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DISEASES DUE TO PROTOZOAN PARASITES.

TEICHMANN (Ernst). **Die Empfindlichkeit von Naganastämmen gegen Arsen und Antimon.** [The Sensitiveness of Nagana Strains to Arsenic and Antimony.]—*Biochem. Ztschr.* 1917. June 4. Vol. 81. No. 5–6. pp. 284–318. With 39 tables.

It has often been stated that all strains of trypanosomes are not equally sensitive towards the same drug; for example, trypanrot has a powerful effect on the trypanosome of mal de caderas, *T. equinum*, whereas it has only a feeble action on the nagana trypanosome, *T. brucei*. Also, atoxyl is a good remedy in infections with *T. gambiense*, whereas it has no action on *T. congolense*. In order to determine with certainty whether differences in sensitiveness towards a drug are exhibited by trypanosomes of the same species it is necessary to have for investigation the greatest possible amount of material for purposes of comparison and to carry out experiments under similar conditions. The author had available for his tests seven nagana strains; one of these was a West African strain preserved in rats and mice at the Hamburg Institute for Tropical Diseases since 1911, while the six other strains were brought to Europe in 1913 from German East Africa by BRAUN and Teichmann, and maintained at the Hygiene Institute of Frankfort.

The experiments detailed in this paper were performed on mice, towards which animals the strains varied greatly in virulence. The most virulent after an average incubation period of 2·10 days produced death in 3·95 days; on the other hand, in the case of two of the strains death was not produced until three or four weeks after inoculation, and remissions occurred in the course of the infections. Both the prophylactic and therapeutic action of the arsenic and antimony salts were tested. The course of the infections is carefully set out in the tables. The following are the author's conclusions:—

"The East African nagana strains examined can be clearly distinguished from one another as regards their sensitiveness towards arsacetin and these differences are brought forth whether the drug is used as a prophylactic or as a therapeutic agent.

"The West African strain maintained for a long while in European laboratories is almost insensitive to arsenic.

"This is equally true for infections arising from inoculation of single individuals as well as for such derivatives of these strains as have become fast against their antibodies.

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"Similarly the East African strains and the West African strain showed differences in sensitiveness towards potassium antimony tartrate.

"So far as duration of action is concerned, the prophylactic use of potassium antimony tartrate is capable of giving as satisfactory results as the therapeutic use of the drug according to the methods employed in these experiments.

"Arsacetin is a more effective curative agent than potassium antimony tartrate in the case of the East African nagana strains examined.

"Not every strain exhibits the same degree of sensitiveness to prophylactic and to therapeutic treatment with arsenic or with antimony.

"The virulence of the strains examined does not bear any relationship to their drug sensitiveness.

"Each of the strains considered exhibits a specific difference in its behaviour towards arsenic and antimony. Its sensitiveness, moreover, is not directed towards chemical influence in general; it must be specially determined for each single drug."

PONSELLE (A.). **Déterminisme de la culture du trypanosome de la grenouille, *Trypanosoma rotatorium* Mayer, 1843.** [Factors determining the Cultivation of the Frog Trypanosome.]—*C. R. Soc. Biol.* 1917. Nov. 10. Vol. 80. No. 17. pp. 824–826.

While studying bouillon blood medium, one of the most suitable for the cultivation of the frog trypanosome, it was found that the indispensable action of the broth (for it cannot be replaced by normal saline solution or ordinary water) was due not to its particular nutritive substances but to its acidity. The peptone broth usually employed in bacteriological laboratories and made slightly alkaline towards litmus is always acid towards phenolphthalin, especially after sterilisation. This acidity is due in great part to the presence of monobasic alkaline phosphates which are present in a high proportion in addition to the di-basic phosphates. It is the passage from a neutral medium such as blood to an acid medium which brings about in the frog trypanosome the series of divisions resulting in the so-called cultural forms.

By mixing one volume of infected frog blood with 10 volumes of an artificial broth made without meat and containing certain inorganic compounds, the flagellate cultural forms are obtained in less than 24 hours afterwards. In the absence of mono-potassium phosphate, or when this compound is replaced by the di-basic phosphate, the trypanosomes preserve their normal blood form without any tendency to cultural evolution. Peptone (1 per cent.), gelatine (0·5 per cent.), or even agar (0·1 per cent.) protects the cultural forms against the trypanolytic action of frog blood, probably owing to their absorbent power. This trypanolytic action of the blood is not directed against the normal blood forms but it appears to cause their destruction as soon as they begin to pass into cultural forms.

KRUMBHAAR (Edward B.). **Experimental Trypanosomiasis: *T. equiperdum* Infection in the Dog.**—*Jl. Infect. Dis.* 1918. Jan. Vol. 22. No. 1. pp. 34–42. With 2 tables & 5 charts.

The author's investigations were performed with the object of producing experimental haemolysis in dogs in order to study the relation of the spleen to blood destruction and regeneration. Chemical reagents employed for this purpose produced only a transient effect

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and thus *T. equiperdum*, the casual agent of dourine in horses, was employed. In this short article the author reports upon the morbid changes set up by these inoculations.

"At first, dogs were injected intraperitoneally with infected rat's blood containing approximately 600,000,000 *T. equiperdum*. As, however, infection did not always result, all subsequent inoculations were given intravenously and the procedure adopted of injecting 1 c.c. per kilo of body weight, of whole blood from a heavily infected dog, without further attention to the actual number of trypanosomes present.

"Such inoculations were successful in all instances except two: in one of these a second attempt proved successful, in the other, no further attempt was made. A few attempts to transmit the infection to guinea-pigs and rabbits were entirely unsuccessful. Our conclusions are based on the study of 28 infected dogs."

The author's observations are summarised as follows:—

"Dogs may be readily infected with *T. equiperdum* and a severe anemia be produced. The incubation period varies from 3 to 8 days, and a fatal termination results in from 3 to 7 weeks. By successive transmission through dogs the virulence of the infection may be increased so that both incubation period and duration of the disease may be shortened and the maximum anemia more quickly reached.

"With the appearance of trypanosomes in the circulating blood, the animals show general weakness, loss of weight, lethargy, and a lessened tendency to the healing of wounds. Subcutaneous edema is a common manifestation and may appear as a general anasarca or be limited to the genitalia or the extremities. The edema fluid contains living trypanosomes. Another interesting and almost constant lesion is keratitis. Choluria is constantly present without evidence of jaundice in the skin or mucous membrane.

"The anemia which develops is progressive and of the hemolytic type. The hemoglobin may fall to 40, and the red cells to less than 3,000,000 per c.c.

"Attempts at regeneration are shown by the increased number of skeined cells, occasional nucleated reds in the peripheral stream, and hyperplastic bone marrow at necropsy. That this attempt at repair is entirely inadequate, however, is shown not only by the progressive lowering of hemoglobin and erythrocyte count, but also by the leukopenia, diminution in platelets, later lowering of percentage of skeined cells, and disappearance of nucleated red blood cells from the peripheral blood stream.

"The principal pathologic changes are the usual degenerative lesions of anemia in the parenchymatous organs, hyperplasia of the bone marrow and a great enlargement of the spleen.

"Splenectomy at the height of the trypanosome infection has no beneficial influence, but rather the reverse, on the anemia or the course of the infection. Animals splenectomized before infection died more quickly than did those with intact spleen; as a rule, within 2 or 3 days after the appearance of trypanosomes in the circulating blood.

"The intravenous injection of arsenobenzol, 3 injections at intervals of 3 days, has been followed by a disappearance of all symptoms and of trypanosomes from the blood and of a prompt improvement in the blood picture. In some instances, however, the disease has recurred on the discontinuance of treatment."

Woods (Alan C.) & Morris (Harold H.). **Complement Fixation in Experimental Trypanosomiasis.**—*Jl. Infect. Dis.* 1918. Jan. Vol. 22. No. 1. pp. 43–48. With 4 tables.

Summary. "Dogs infected with *T. equiperdum* develop complement fixation with a specific antigen within 8 days after inoculation. An easily

prepared and a very satisfactory antigen is the salt solution extract of the spleen of a rat heavily infected with trypanosomes or dead from the infection. The complement fixation usually follows the appearance of trypanosomes in the blood, although it may occasionally precede the appearance of trypanosomes. The complement fixation, however, always antedates the appearance of symptoms.

"Dogs infected with trypanosomes frequently give a positive Wassermann reaction.

"Within 3 weeks after the appearance of trypanosomes in the blood, the serum of the infected dog becomes strongly anticomplementary. This anticomplementary phenomenon appears to be due to the liberation of anticomplementary substances into the blood by the invading trypanosomes.

"The blood is rendered sterile, and all clinical symptoms clear up following the intravenous injection of arsenobenzol, and in the only complete experiment at hand, the anticomplementary action and complement fixation properties with the trypanosome and Wassermann antigens likewise disappeared."

LAVERAN (A.) **Sur les leishmanioses expérimentales, et en particulier sur la leishmaniose canine, chez la souris blanche.** [Experimental Leishmaniasis, with Special Reference to the Effects of Canine Leishmaniasis on the White Mouse.]—*Bull. Soc. Path. Exot.* 1918. Mar. Vol. 11. No. 3. pp. 205–216.

In 1912 Laveran showed that the virus of kala azar was capable of producing in the white mouse visceral lesions bearing great resemblance to those observed in natural cases of the disease in man and since that date he has utilised this small rodent very considerably for the study of the various leishmaniases. In 1916 a culture of Leishmania which had been sub-cultivated 112 times in N N N medium and originally isolated from a natural case of infection in the dog was obtained from Tunis from Ch. NICOLLE, together with a dog which had been inoculated with virus from a bitch suffering acutely from the natural disease. It was found possible to infect white mice fairly easily by inoculating them intraperitoneally with the Leishmania obtained direct from dogs or from mice affected with leishmaniasis of canine origin. The infection was, on the other hand, difficult to set up by means of the cultures of these Leishmania. The infection, which ran a fairly chronic course, became localised principally in the liver and in the spleen.

On comparing these results with those obtained after inoculation with the viruses of the other leishmaniases the author draws the following conclusions :—

(1) The infection produced in the white mouse by the virus of natural canine leishmaniasis bears the greatest resemblance to the infection produced in this animal by the kala azar virus (Mediterranean or Indian). In both cases a visceral infection is produced, localised chiefly in the spleen and in the liver, and transmissible with difficulty by means of cultures of the Leishmania.

(2) In the case of male mice inoculated intraperitoneally with *L. tropica* (cultures or material obtained from the human subject or infected animals) one often observes after a certain interval in the testicular region swellings due to the multiplication in the testicles and surrounding connective tissue of large numbers of Leishmania, and these enlargements often become complicated with necrosis of

the overlying skin and oedematous swellings. If invasion of the internal organs takes place it is as a rule secondary in occurrence.

The fundamental differences between the infections due to *L. donovani* and those due to *L. tropica* in man, monkeys, and the dog as regards the seat of the lesions are less distinct in the case of the mouse. The cutaneous changes in the latter animal may become complicated with lesions in the internal organs or even be entirely absent.

HALL (Maurice C.) & WIGDOR (Meyer). **Canine Coccidiosis, with a Note Regarding Other Protozoan Parasites from the Dog.**—*Jl. Amer. Vet. Med. Assoc.* 1918. Apr. Vol. 53. (New Ser. Vol. 6.) No. 1. pp. 64–76. With 1 text-fig.

In a recent paper Hall (1907) described the occurrence of a coccidian parasite in 15 out of 200 dogs examined in Detroit, U.S.A. The parasite on further examination by the above authors is now concluded to be *Diplospora bigemina*. The coccidium showed a marked tendency to occur in adherent groups in the faeces. "Stiles (1892) notes that this species occurs in dogs and cats and in the polecat *Putorius putorius*. Railliet and Lucet (1891) have reported these as different varieties, *Coccidia bigeminum canis*, *Coccidia bigeminum cati*, and *Coccidia bigeminum putorii*. Weidman (1915) has reported another variety *C. bigeminum canivelocis* from swift foxes in the western United States" [see this *Bulletin*, Vol. 4, No. 1, p. 24]. "Stiles notes that the coccidia from the intestine of the dog which have been referred to by various authors as *Coccidium perforans*, the form from the rabbit intestine (regarded by some workers as identical with *Eimeria stiedae*), are probably *C. bigeminum*. Recently Guillebeau (1916) has reported *Eimeria stiedae*, the coccidium commonly found in the liver of rabbits, from the liver of dogs" [this *Bulletin*, Vol. 5, No. 1, p. 5], "but in his review of this paper Railliet concludes that the organisms described are not coccidia, but blastomycetes. Raillet does not regard the hepatic organisms described by Lieniaux, Clark, Marcone, or Olt as coccidia, and notes that forms described by Perroncito are trichosome eggs. He believes that *Diplospora bigemina* from the mucosa and sub-mucosa of the intestinal villi is the only coccidian known from the dog, and that while hepatic coccidia may occur in the dog no case of the sort has been established."

In the case of the material examined by the authors the oocysts measured 36 to 40μ long by 28 to 32μ wide. FANTHAM (1916) gives a range of 22–40 by 19–28μ for the oocyst of *D. bigemina*. These forms had two spores, each spore measuring 10 to 20μ in diameter, and each spore contained four sporozoites, each 12μ long by 4μ wide, and a residual body. In one animal a smaller strain of coccidia was found, the oocyst measuring 20 by 18μ, the spores 12 by 11μ, and the sporozoites 10 by 3μ.

Under favourable temperature conditions (22 to 29° C) the oocysts placed in 10 per cent. potassium bichromate solution appeared to develop infective sporozoites in two days. It was shown, however, that when the faeces were kept under less favourable conditions, resembling those found in nature, the process of sporulation might take two weeks or even longer. As a result of some feeding experiments it was found that from the time of the ingestion of oocysts

containing infective sporozoites to the appearance of oocysts in the faeces of the dogs a period as short as three or four days to as long as 11 or 12 days might elapse; the oocysts then disappeared in all cases from the faeces in a few days except in one animal in which oocysts were present for 12 days. Repeated attempts to infect the latter animal subsequently failed, apparently showing that it had an acquired immunity to coccidiosis. On the other hand, CRAWLEY (1912) dealing with the self-elimination of coccidiosis stated that no immunity is produced in this disease and that another attack might result from a fresh infection from without. In the case of naturally infected dogs no apparent abnormality was discoverable in the digestive tract on post-mortem examination. However, when dogs were fed experimentally with large numbers of coccidia haemorrhagic conditions were stated to have been set up. The disease is said to be afebrile although the authors' experiments suggested that there was a slight elevation of temperature on the days during which oocysts were present in the faeces. Sometimes diarrhoea with the presence of gas and blood in the faeces appeared to be set up as the result of the coccidian infestation.

HADLEY (P. B.) i. **The Role of the Flagellated Protozoa in Infective Processes of the Intestines and Liver.**—*Rhode Island Stat. Bull. 166.* 1916. pp. 3–40. With 3 plates. [Extracted in *Exper. Stat. Rec.* 1917. Apr. Vol. 36. No. 5. pp. 483–484.]

ii. **The Avenue and Development of Tissue-Infection in Intestinal Trichomoniasis.**—*Ibid.* Bull. 168. pp. 3–64. With 11 plates & 2 text-figs. [Extracted in *Exper. Stat. Rec.* 1917. June. Vol. 36. No. 8. pp. 781–782.]

i. In 1895 Theobald SMITH figured as the cause of the so-called "blackhead" disease of turkeys an amoeba which he called *A. meleagridis.* Since that date several authors have taken up the study of this subject and many of them have attributed the disease either to a coccidian or to a flagellated parasite. Hadley's recent investigations detailed in the above two articles tend to incriminate as the etiological factor a flagellated protozoan, Trichomonas, which may be found not only in turkeys, but also in the intestines of all poultry as well as of most other animals. "In the intestines the flagellates are present in the cecal contents, but are found mostly in the mucous layer overlying the epithelium, and often deep in the crypts of Lieberkühn. Reproduction is by simple fission taking place mainly in the cecal content; also by encystation and spore formation, probably the common method of reproduction in the tissues. Ameboid forms are also encountered, especially in the tissues."

The following conclusions appear in the original article:—

"The gross pathological picture includes congestion and enlargement of portions of the whole or part of one or both ceca, together with the presence of large, circular, yellowish, discrete or confluent, necrotic areas on the liver. These foci extend deep into the tissues. Frequently the ceca may contain a solid, cheesy or leathery, yellow or blood-stained core, composed of coagulated serum, fibrin, and cellular elements. The lumina are frequently quite obliterated. Fusions between the ceca and loops of the intestine, liver, or gizzard may sometimes occur; also between the liver and proventriculus.

"The microscopical pathological features involve the penetration of the epithelial wall by the parasites and a progressive infection of the subepithelial tissues, where the mode of reproduction is by encystation and spore formation. The result of rapid reproduction is great thickening of the cecal wall. In favorable specimens many of the features of flagellate morphology can be observed in the parasites located in these regions. The liver presents a corresponding appearance of the infecting elements, though more modified by their location.

"Very rarely the pathological condition may be complicated in the liver by an amebic infection (not *Amoeba meleagridis*) and in the ceca by both amebas and coccidia (*Eimeria avium*). The picture may also be complicated by infections with Hemoproteus.

"The nature of the infective process, together with extensive clinical experience, makes it clear that intestinal flagellatosis can not be regarded as an infectious disease, and that Trichomonas as found in these infections can not be looked upon as a pure parasite. A successful infection depends upon factors present in the host, and is probably quite unrelated to 'virulence' on the part of the infecting organism. In this sense the infection, commonly called 'blackhead' of turkeys, can not be regarded as an infectious or communicable disease.

"The parasitic flagellates here described are identical with some of the bodies earlier regarded by the writer as stages in the development of the coccidium, Eimeria. They are also identical with bodies described by Theobald Smith under the name *A. meleagridis*, of whose existence, as an ameba, up to the present time no conclusive evidence has been brought forward."

ii. In the second article Hadley reports upon the manner in which the flagellates responsible for the intestinal trichomoniasis penetrate the caecal epithelium and enter the sub-epithelial tissues, there to produce characteristic lesions, and describes the course of the infective process.

"As a result of a more or less fluid condition of the cecal content the flagellates multiply in vast numbers by autogamous reproduction and finally migrate into the crypts of Lieberkühn, where they tend to gather at the terminal branches and produce a marked bulging of the fundi.

"Either through pressure or natural invasive power, or both, the free motile flagellates (trophozoites) penetrate the goblet cells, force out the nucleus, or push it on one side, break through the base of the cell, subsequently through the basement membrane, and enter the connective tissue of the mucosa. A large number of flagellates may penetrate the same rift in the epithelial wall and subsequently become disseminated.

"With the further passage of flagellates through the epithelial wall they tend at first so to congregate as to separate the epithelial wall of the fundus from the basement membrane and from the core of the villus. The first mechanical effect upon the epithelial cells of the fundus is the production of a ragged, fringed appearance at the basement end.

"Either as a result of the mechanical damage brought about by the earliest of the invading flagellates or due to the effect of toxic metabolic products, the epithelial cells at the fundus of the crypts become further disorganised, permit other flagellates to pass, probably through intracellular rifts, and finally degenerate, leaving at the site of the fundus only free nuclei, cellular debris, and flagellates. Sometimes the epithelium of the fundus is pushed downward through the crypt-space without becoming fully disorganised.

"Through the subsequent migration of round cells and endothelial or other phagocytic cells into this region, the area (the crypt-space) becomes consolidated. At the same time many of the flagellates are surrounded by endothelial cells, while others proceed to invade further the core of the villus and the muscularis mucosae. The terminal portions of the epithelium usually remain intact at this stage.

"At this point the motile forms of the flagellates for the most part disappear and further multiplication in the tissues is continued by autogamous reproduction. At the beginning of this stage of development

most of the parasites lose both the membrane and flagella, together with other organelles which characterise the trophozoite, and appear as the round or oval bodies, staining pink with eosin, which are regarded by Smith as amebas (*Amoeba meleagridis*).

"With the continued invasion of other crypts, followed by similar consolidations, the deep-lying cecal epithelium becomes parasitized, fusions with adjacent structures may occur, and secondary bacterial infections intervene. A secondary flagellate invasion of the ceca may occur through the outer serous covering as a result of contact-infection from the liver.

"With the further progress of the infection the parasites disseminate through the reticular tissues of the core of the villi and produce a sort of 'reverse infection,' attacking from the rear the epithelium overlying the terminal portions of the villi. With the gathering of parasites between the wall and the basement membrane the epithelium is first straightened and finally forced off. This is the culmination in the process leading to a more or less complete destruction of the cecal epithelium and a liberation of some of the parasites into the cecal canal.

"In explanation of the circumstances leading to the active invasion of the crypts, the data at present in hand makes it appear probable that an earlier diarrheal condition present in the lower intestine and ceca is mainly responsible for the great multiplication of the flagellates (autogamy) in the cecal canal and for the subsequent invasion of the crypts. It seems much less probable that the flagellates in themselves can be regarded as the cause of the initial diarrheal state. . . .

"True amebas, chiefly *A. intestinalis*, are frequently present in the ceca, sometimes in numbers, but only in exceptional cases can it be concluded that they are of pathogenic significance in the production of cecal lesions. Aside from those cases in which it is identical with the schizont stage of *Eimeria avium*, *A. meleagridis* must be regarded as the late trophozoite (rounded) stage of the intestinal flagellate, Trichomonas."

CHATTON (Edouard) & BLANC (Georges). **Notes et réflexions sur le toxoplasme et la toxoplasmose du Gondi** (*Toxoplasma gundii* Ch. NICOLLE et MANCEAUX 1909). [The Toxoplasm and Toxoplasmosis of the Gundi.]—*Arch. Inst. Pasteur de Tunis.* 1917. Oct. Vol. 10. Nos. 1 & 2. pp. 1–40. With 4 tables and 1 plate comprising 15 figs.

The gundi is a herbivorous rodent found on the borders of the Sahara Desert in Southern Tunis and living in the crevices among the rocks and ruins in the dry mountainous districts. It is used as a laboratory animal at the Pasteur Institute of Tunis and it was in this animal that the new genus of protozoa known as Toxoplasma was first discovered (1908) by CH. NICOLLE and MANCEAUX. Simultaneously the parasite was also described by SPLENDORE in the domestic rabbit in Brazil. Since that date toxoplasms have been identified in a number of other animals including the dog, a monkey, various rodents, several birds, and a snake in different parts of the world; also, special interest is attached to these organisms owing to the discovery by CASTELLANI (1913) of protozoa-like bodies very similar in appearance to them in a case of protracted fever and splenomegaly in the human subject in Ceylon. Hitherto attention has been chiefly devoted to the study of toxoplasmosis in the gundi, and since 1908 a number of observations on the subject have been made by CH. NICOLLE and his fellow workers at the Tunis Institute, and under his direction the above two authors undertook to continue the study under natural conditions. This study had been commenced by Miss PIXELL [see this *Bulletin*, 1914, Mar. Vol. 2, No. 1, p. 38].

The following is a summary of their observations and conclusions.

Among mammals the gundi is the animal in which toxoplasms have been most frequently and most constantly observed.

The disease is distinctly and regularly seasonal. The morbid season occurs during the coldest time of the year, that is from October to the end of February. In Brazil, in the case of the rabbit, toxoplasmosis shows the same peculiarity when account is taken of the inversion of the seasons (SPLENDORE).

Hitherto toxoplasmosis has only been discovered in gundis that have been kept at least 17 days in captivity at the Pasteur Institute of Tunis. Four hundred gundis were examined in order to determine whether the virus could be found in animals living under natural conditions but negative results only were obtained. These results, however, do not appear to be sufficient to enable one to assert that the gundis contract the disease at the Tunis Institute.

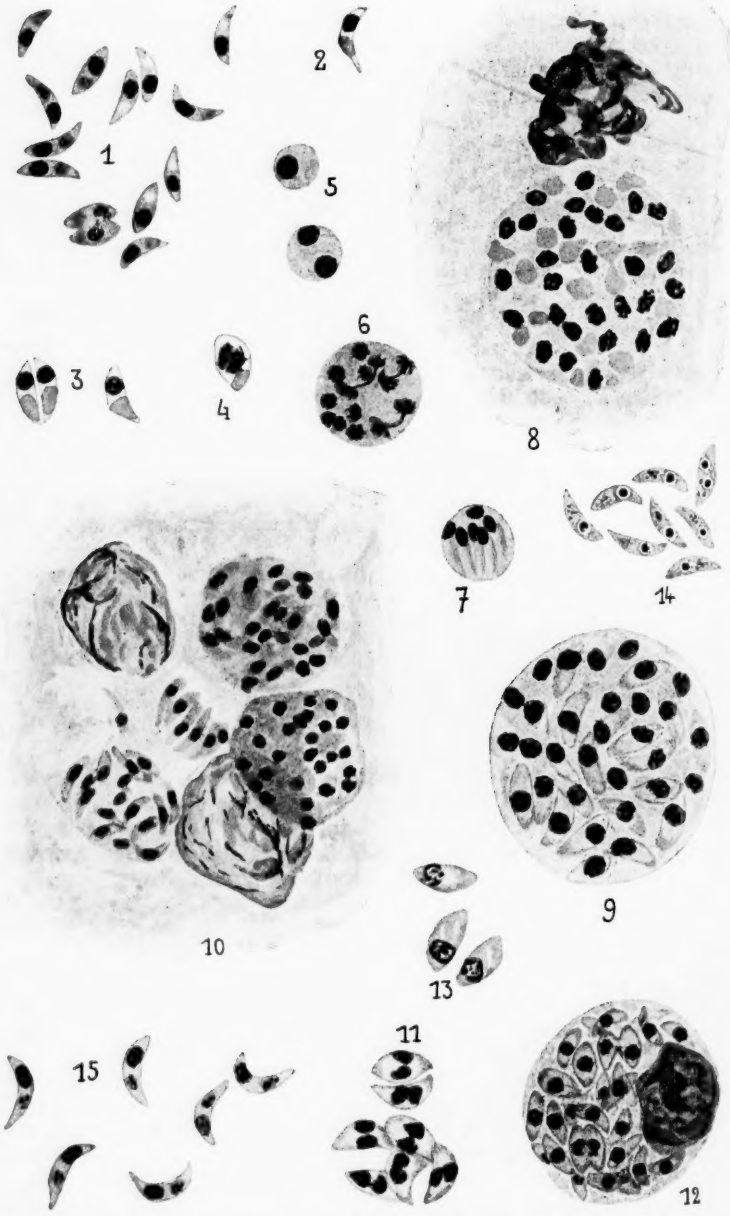
The natural ectoparasites of the gundi are the ticks *Rhipicephalus sanguineus* Latr. abundant especially in the nymphal stage, and *Hyalomma* sp. occasionally found in the nymphal stage; a mite *Trombidium* sp. abundant in the larval stage; a flea, *Coenopsylla mira* Rotsch. peculiar to the gundi and rarely found; two diurnal biting flies, viz., a Chironomid *Thersestes* (*Mycterotypus*) *laurae* Weiss and a Simuliid *Simulium liniatum*, and probably other nocturnal flies that bite man and other mammals in the neighbourhood of water also occasionally attack the gundi. Of these parasites only the Rhipicephalus and the mite seem possible carriers of toxoplasms in nature though neither these nor the other parasites mentioned breed on the gundi in captivity. As possible vectors in the laboratory *R. sanguineus*, of canine origin, *Dermanyssus* sp. from birds, *Ctenocephalus serraticeps* (dog flea) and *Cimex lectularius* (bed bug) should be considered.

Two dogs, one in 1910 and the other in 1917, appeared to have contracted toxoplasmosis at the Pasteur Institute of Tunis where the kennel adjoined the gundi cage.

The gundi is apparently the most susceptible animal to its own virus. Intraperitoneal inoculation, which alone has been hitherto tried, sets up a fatal infection which runs its course in from four to 26 days. The reason for this difference in time is unknown. A fixed virus has been obtained capable of killing the gundi in four and a half days.

Where the disease runs a rapid course it is characterised by an abundant peritoneal exudation without manifest visceral lesions, thus differing from the natural disease. In cases where the disease develops slowly visceral lesions and enlargement of the liver and spleen are produced similar to those of the natural disease.

After the gundi the mouse is the most susceptible species (Ch. NICOLLE & M. CONOR). The duration of the disease and its morbid anatomy depend on the channel of inoculation (MESNIL and SARRAILHÉ, SARRAILHÉ). Many other small rodents are susceptible to intraperitoneal inoculation. The white rat is resistant; the rabbit can rarely be infected except by intravenous inoculation and the dog can only be infected in this way (LAVERAN and MARRULLAZ). The cat is more susceptible than the dog; the receptivity of the pigeon is inconstant.



Toxoplasma gundii Ch. Nicolle & Manceaux in the gundi.

[Reproduced by permission from the *Archives de l'Institut Pasteur de Tunis.*]

It is hardly possible to differentiate between the different species of toxoplasms from the results of experimental infection. The difference in susceptibility of the various species of animals is very small; animals of the same species show a variable degree of susceptibility to the same virus and different strains of the same toxoplasm vary in virulence towards animals of the same species.

The characteristic form of the toxoplasm is the crescentic form showing different shaped poles, a single nucleus, no flagella, and a paranuclear secretory differentiation. It corresponds morphologically exactly with the rhabdogenetic form of DELAGE and HÉROUARD, characteristic of the true sporozoa.

There appear to be two methods of multiplication viz., (1) binary longitudinal division (tomogony) of the crescents (tomonts) which takes place especially in the lymphatic cells, and, (2) occasionally schizogony, which takes place in the fixed visceral cells.

The schizogony is of the coccidian type and this phenomenon together with the rhabdogenetic structural type of the crescent places the toxoplasms undoubtedly among the sporozoa.

On the other hand the tomogony, which is absolutely exceptional in sporozoa (Babesia), is a very remarkable character which the toxoplasms appear to have maintained from their flagellate ancestors.

Briefly the toxoplasms should be ranked among the sporozoa in close proximity to the coccidia, and should probably be considered on account of their longitudinal division as more nearly related to the flagellate source, which is now generally attributed to all rhabdogenetic sporozoa.

The failure to cultivate toxoplasms on artificial media is attributable to their sporozoan nature.

See figures on opposite page.

In part taken from the preparations of CH. NICOLLE. All the figures are magnified 1,750 diameters. The differences in size and form of the crescentic elements are accounted for by the different degrees of desiccation and spreading of the smears before fixation.

1. Isolated tomonts; normal form and dimensions. The fusiform elements must be considered as forms about to undergo fission, paranuclear area more or less visible. Experimental toxoplasmosis; ascitic fluid (osmic acid vapour, normal fixation, Giemsa).

2. Tomont with elongated posterior pole and well differentiated paranuclear area. Natural toxoplasmosis; lung (osmic acid vapour, normal fixation, Giemsa).

3–4. Isolated tomonts of the same type, one dividing form and the other two produced by fission. Natural toxoplasmosis; lung (osmic acid vapour, Giemsa).

5. Young schizonts, with one or two nuclei. Natural toxoplasmosis; liver (alcohol, Giemsa).

6. Schizont in more advanced stage, the nuclei dividing (haplomitosis). Natural toxoplasmosis; liver (alcohol, Giemsa).

7. Small-sized ripe schizont with schizozoites arranged in barrel fashion. Natural toxoplasmosis; liver (alcohol, Giemsa).

8. Large-sized unripe schizont enclosed in a crushed pulmonary cell. The paranuclear areas of the schizozoites are differentiated. Natural toxoplasmosis (osmic acid vapour, Giemsa).

9. Ripe schizont extracted from its host cell. Natural toxoplasmosis; liver (alcohol, Giemsa).

10. A group of schizonts in different stages within a binucleate crushed pulmonary cell. Natural toxoplasmosis (osmic acid vapour, superfixation, Giemsa).

11. Group of bi-nucleated tomonts in process of fission. Natural toxoplasmosis; liver (alcohol, Giemsa).

12. A pseudo-schizont or mass of tomonts resulting from fissiparous divisions within a mononuclear leucocyte. Experimental toxoplasmosis; ascitic fluid (osmic acid vapour, slight superfixation, Giemsa).

13. Tomonts distorted by desiccation. Artificially produced ovoid form. Experimental toxoplasmosis; ascitic fluid (osmic acid vapour, insufficient fixation, Giemsa).

14. Tomonts fixed in the wet state with Bouin-Duboscq's fluid and stained with iron-haematoxylin. True structure. Experimental toxoplasmosis in the mouse with *T. gundii*.

15. Group of eimerian schizozoites in a smear from a fragment of intestinal mucous membrane from a cat affected with coccidiosis (due to *Eimeria* nov. sp.) to illustrate the coccidian form and structure of the tomonts and schizozoites of Toxoplasma (osmic acid vapour, Giemsa).

DISEASES DUE TO METAZOAN PARASITES.

SIMPSON (James J.). **Bionomics of Tsetse and Other Parasitological Notes in the Gold Coast.**—*Bull. Entom. Res.* 1918. Feb. Vol. 8. Pts. 3 & 4. pp. 193–214.

This report is based on observations made from Sept. 1915 to Feb. 1917 in an area lying partly in the Northern Territories of the Gold Coast, partly in Togoland, and drained by the River Volta. It extended from 8° N. to 9° 45′ N and from 0° 15′ E to 2° 30′ W. A report dealing with the vegetation of this region has already been given by the author in 1914 [see this *Bulletin*, Vol. 2, No. 3, p. 148].

Dealing with the factors influencing the distribution and prevalence of tsetse the author mentions that several writers on this question in West Africa refer to "fly belts." However, according to the author's experience in that territory, he has no knowledge of any definite locality, either in the wet or dry season, containing tsetse actually cut off from the surrounding country. "To a casual observer this might appear to be so, but if the immediate country be thoroughly examined, it will be found that tsetse exist linking up these so-called belts, though undoubtedly in smaller numbers." "At the end of the dry season (December to February in West Africa), when the forest fires are raging, tsetse (along with game) are undoubtedly driven before them and take refuge in the denser bush unattacked by such fires, but the pupae are seldom damaged and soon repopulate the area burnt, in addition to the adults which return after a short time." Thus, "in the Northern Territories of the Gold Coast there is hardly a square mile where tsetse cannot be captured at some period of the year. This is extremely important in the case of horse transport. In these Territories certain areas are 'proclaimed' for horses, but this precaution only leads to a false security. There is no road between any two stations in the Northern Territories free from tsetse, and as it is not the actual number of flies, but the proportion infected that counts, such a regulation is worse than useless."

With regard to the influence exerted by the type of vegetation the author's observations indicate that *Glossina palpalis* is found along

the banks of rivers where vegetation is dense, in "kurimis" (dense bush with abundant shade), and along the banks of the smaller tributaries. *G. tachinoides* is an up-country form allied to *G. palpalis*, and is found in similar localities on the higher reaches of the rivers. *G. submorsitans* is seldom found near rivers and is more abundant in the savannah forest and open savannah country; the species was found at least three miles from the nearest water. In very open country where small water holes exist, *G. submorsitans* is more frequent, but this may be, and probably is, because game comes to water there. *G. submorsitans* will, however, follow a herd of game a long distance, and undoubtedly migrates in this manner.

The author quotes LLOYD's statement that a small proportion of females and a large number of pupae may be collected where game is plentiful. This is also borne out in West Africa. When game is abundant the females manage to feed easily and when fully engorged retire to the seclusion of some shady place; they are also able to propagate more rapidly, consequently the number of pupae is increased. All over the Northern Territories the close association between *G. submorsitans* and game, and especially the dog-faced baboon, is very marked.

Humidity appears to be the prevailing factor influencing the numbers of tsetse. At the beginning of the dry season these insects increase greatly in numbers. Whereas actual sunshine only affects the daily period of activity, a hot sun most strongly affects *G. palpalis*, which seldom follows one in direct sunlight. *G. tachinoides* is next affected, whereas *G. submorsitans* will follow and attack in the open in the hottest sun, but seldom at night. ROUBAUD states that *G. morsitans* when exposed to a temperature of 40° C (104° F) died within an hour. This was not found to be the case in the Northern Territories. The flies were frequently caught in the open at a time when the temperature was from 109° to 112° F. For this reason, when cattle, horses, and other animals have to be transferred from one place to another, this should be done if possible during the night.

An account of a new variety *G. palpalis* var. *pallida* is next given.

Dealing with the food of Glossina the author quotes numerous observations of his own and other authors showing the percentage of mammalian and non-mammalian blood found imbibed in these flies. These proportions vary considerably in different observations, but it appears that *G. morsitans* is much more dependent on mammalian blood than is *G. palpalis*. A considerable number of *G. tachinoides* were examined by the author whose figures are, in the case of that fly, mammalian 67·3 per cent., non-mammalian 32·7 per cent. The source of the non-mammalian blood seems to be mainly reptilian. The flies were found to gorge themselves repeatedly on certain reptiles kept in captivity whereas they could not manage to obtain a full meal from birds unless these animals were tied down. The chief source of mammalian blood for *G. tachinoides* appears to be a large yellowish-brown bat which sleeps during the day in a suspended position in the dense overhanging trees in localities where the flies abound. No tsetse were ever found to imbibe water or seen to drink an exposed liquid. Attempts were made to feed the flies on liquids covered with a membrane composed of rats' skin and on various fruits but in no case was any liquid ever imbibed except

fresh blood. The percentage of mammalian blood to non-mammalian blood differs greatly in the case of *G. submorsitans.* Only 2·3 per cent. were found to contain nucleated blood corpuscles and this would be accounted for by the fact that the fly abounds in open country away from water where there is practically no reptilian fauna. Tsetse were never seen to imbibe fresh blood from the open wounds of shot animals but always pierced the skin to imbibe blood.

The question concerning the disparity in the proportion of sexes in Glossina has attracted the attention of many observers in various parts of Africa. After quoting some statistics given by other observers the author details a number of figures showing the percentages of sexes caught at various seasons of the year together with the rainfall during those periods. As at certain times *G. tachinoides* predominated in the areas visited and at other times *G. morsitans* predominated the author was unable to make a consecutive study of either. Judging from the data set forth in the case of *G. tachinoides,* the one outstanding feature exhibited by these figures is stated to be that the percentage of males decreases as the rains gain in intensity and the humidity increases ; i.e., the percentage was found to decrease from between 60 and 70 down to just under 50 under those conditions. A much greater disparity in the proportion of the sexes was found in *G. submorsitans.* The general average worked out at from 90 to 95 per cent. of males but there were certain discrepancies, e.g., in June at one place the percentage was only 46, while in August it was 85.

Some interesting experiments were made in order to determine the distances Glossina might travel. A certain number of marked *G. tachinoides* were liberated from various points on a road alongside which ran two small streams. The experiments were carried out during the wet season and during the dry season. During the latter season there was no water in the streams, but they contained a considerable quantity of water during the wet season. The flies were liberated at night and were fed before they were allowed to escape. From these experiments it was found that a few rare specimens were capable of covering a maximum distance of four miles, and that the great majority did not return over a greater distance than two miles. All seemed to return to the water as none were caught at a greater distance from the river than the point from which they were liberated. If there was any intermediate water between the place where the tsetse were liberated and the large river the tsetse discovered this and were making their way down stream to the large river. Where there was a shade on the bank of a stream, but no water, the tsetse congregated there and did not attempt to proceed towards the large river. A thorough examination of the open bush on each side of the road revealed not a single tsetse at a greater distance than 200 yards. There was practically no discrepancy in the proportion of the sexes re-captured. It was found impracticable to perform similar experiments in the open bush. On another occasion numbers of tsetse were liberated along the bank of the river. The greatest distance covered by a single tsetse was seven miles while numerous flights of two to four miles were observed. It was most probable, however, that these had followed the numerous canoes plying constantly on the river.

Ten experiments were performed in order to ascertain how far tsetse would follow a herd of game. In half of these tests the flies

were disturbed continuously with fly switches, while in the other half they were not molested. In both sets of experiments it was found that after five miles had been traversed the tsetse (*G. submorsitans*) either had all managed to feed or had given up the attempt and disappeared.

The problem of how to devise measures for the diminution of tsetse in a given area is of very considerable importance. It has been repeatedly shown that in the case of villages a clearing of about 400 yards around their outer circumference will practically restrict the tsetse to a region outside this area. This clearing must, however, be kept up continuously; otherwise the scrubby vegetation which later appears proves very suitable for the flies. These measures can also be applied to the fords of rivers and the main roads in a district.

In a restricted area such as, for example, the Island of Principe, systematic trapping has had very beneficial results. In wide areas, such as any of the colonies of West Africa the conditions are totally different; for example, along a portion of the River Volta examined the author found that there was not one half-mile in the whole area where *G. tachinoides* was not present in abundance. Five experienced men were posted for four months alongside a ferry across this river for the purpose of ascertaining whether by systematic trapping a diminution in the number of tsetse would be brought about at the end of that time. No reduction in numbers was, however, effected.

Systematic trapping with bird lime was found to be less satisfactory than by means of nets. Four colours of paper were used, light brown, red, black waterproof, and green. The following were the average number captured daily in these nets, five men being used for each colour :—Light brown 103, red 89, black waterproof 79, green 45.

The author then tried liberating tsetse in a closed room and smearing the bodies of collectors with the following oils and essences :—oil of bergamot, oil of cloves, beechwood oil, oil of lavender, cedar wood oil, beechwood creosote, essence of orange, and essence of lemon. The tsetse were allowed to alight on and bite the collectors, and only in two cases did the substances seem to act as deterrents, viz., in the cases of beechwood creosote and beechwood oil. In the case of oil of cloves and the two essences there seemed to be a marked attraction.

The conservation and increase in the numbers of the natural enemies of tsetse is a subject of importance. Guinea-fowl and bush-fowl have been mentioned by some writers. However, the author examined the stomach contents of 379 of these birds but in no case did he see any remains of either adult tsetse or pupae. An examination of the stomach contents of lizards revealed numerous kinds of insects but never of tsetse. The same was true of the nests of mason wasps. Tsetse are not "fleshy" insects, and are therefore unsuitable as a food for growing larvae. Some carnivorous spiders and dragon flies have been observed to devour tsetse. By far the most important insect enemies of tsetse are asilid flies and wasps of the genus Bembex. The toll of tsetse, of the species *G. tachinoides*, taken by Asilidae is considerable. They follow cattle and horses long distances and the author on many occasions observed an asilid grasp a tsetse about to alight on a horse's neck. Sometimes they would hold a fly on a twig for over a quarter of an hour, occasionally shifting the position of the proboscis, which was inserted into the thorax of the tsetse. Of

24 tsetse put in a mosquito net with six Asilidae all were dead within 24 hours, and all showed signs of having been punctured. Bembex is the most voracious enemy of *G. submorsitans*; it does not alight but darts quickly down and either captures the tsetse on the wing or immediately it has alighted.

The author then deals with the breeding places and habits of Glossina. In the case of *G. tachinoides* reared in the laboratory it was found that the longest time taken by a pupae to hatch was 49 days while the shortest time was 22 days. From the pupae deposited in September only 41 per cent. reached maturity while of those deposited in November 87 per cent. produced adults. Males and females appeared in practically equal numbers but the males died off more quickly than the females. The mortality amongst the males was 35 per cent., amongst the females only 17 per cent.; these figures refer to those which died before taking a meal. 447 pupae of the above fly were collected from the banks of the river in January and February and of these 392 produced adults. The most common situation for the pupae of *G. tachinoides* is in the decayed humus beneath overhanging trees in places which are quite sheltered from heavy rains and are moistened only occasionally by water dripping down and are protected from the sun. No breeding places were found amongst tall grass although adults are very abundant in this material. The principal breeding season of the fly appears to be just after the dry season, when the rains commence, and at the end of the rainy season breeding practically ceases.

The breeding places of *G. submorsitans* are very similar to those of *G. tachinoides* with the exception that on several occasions pupae were found on the clusters of small growth on the top of deserted anthills. The pupae of the *submorsitans* were never found in the burrows of porcupines nor in those of bush-pig and wart-hog as stated by Lloyd. Out of 947 pupae of this fly collected 821 adults emerged (402 males, 419 females); 124 of these died before feeding, the males dying off much more quickly than the females. Intra-uterine pupation was observed on four separate occasions.

The author concludes his observations on Glossina by a few remarks on the parasites of the pupae. Up to the present time no such parasites have been described from West Africa. As, however, there is no hope of exterminating or even diminishing of numbers of tsetse by trapping or other methods of destruction in that territory the author states that our only hope lies in the direction of systematic breeding of parasites and their dissemination in fly-infested areas. Investigations carried out over a considerable period showed that a small proportion of the pupal of *G. tachinoides* was parasitised by *Chalcis amenocles* Walk., which was the only parasite found. From the pupae and empty pupae cases of *G. submorsitans* the author also bred out the above species of parasite and in addition four other species of parasites. The author was able to breed *C. amenocles* in large numbers on the larvae and pupae of Sarcophaga and as species of these insects are abundant around villages it should be possible in a very short time to obtain large numbers of parasites for dissemination.

A short account of the fauna of the Northern Territories is given and a considerable time was spent in the game area to find out what kinds of game harboured parasites. *Trypanosoma pecorum* was found

in the blood of two wart-hog and *T. vivax* in two reed buck. The blood of a haartebeest and of a red-flanked duiker contained a piroplasm resembling *Theileria parva.* The prevailing tsetse of the district, *G. tachinoides,* according to various authors, carries *T. brucei* in its natural state in West Africa. *T. pecorum* was common in cattle and was also found in horses, while one of the author's ponies died of an infection with *T. vivax.* It is rather strange that no specimens of *T. congolense* were found in the blood of game as a large number of the cattle and horse examined were infected with this species. The paper concludes with a list of blood-sucking flies, other than Glossina, and ticks, together with their hosts, found in the area under investigation.

CHRISTY (Cuthbert). **Tsetse Flies and Fly-Belts.**—*Ann. Trop. Med. & Parasit.* 1918. Jan. 31. Vol. 11. No. 3. pp. 279–282.

Species of Glossina belonging to the *morsitans* group are rarely to be found outside certain areas known as "fly-belts." The fly migrates *en masse* from one part of the belt to another but no one seems yet to have afforded a satisfactory explanation why it should migrate within certain limits; the country beyond the fly-belt is often identical in character and type of vegetation but the fly is seldom observed outside the belt even in pursuit of animals. There are two forms of migration within a belt; one due to the burning of the bush in the dry season when the fly retires to the shelter afforded by streams and moist places while the other, in which the flies seem to have certain months of migration, is more difficult to understand. The author is convinced that animals play a very small part in this latter form of migration. He has observed flies swarming around herds of buffaloes at a certain time while a week later not a single fly could be seen on the same herd. On several occasions areas of country were found swarming with fly but containing very few animals to serve apparently as hosts. Such districts are to be found in the Eastern Welle basin and in the Bahr-el-Ghazal. The presence or absence of game depends upon grazing facilities, but these have no relation to the presence or absence of fly; also the prevalence of sleeping sickness has no relation to the number of *morsitans* or to the number of game in these districts. The author considers it is a dangerous assumption to conclude that wild animals are the chief reservoir of the trypanosome of sleeping sickness. He is convinced that the antelopes play a quite negligible part. Pigs, in his opinion, especially the common red river-hog and the wart-hog as well as the semi-domesticated pig, are probably the most dangerous animals. The possibility of exterminating all the wild animals in any part of Tropical Africa is considered quite impracticable, and such a measure would probably have very little effect in eliminating sleeping sickness. In the districts above referred to the blood of 160 wild animals was examined and only in 5 of these were trypanosomes found. Only in the case of one animal, a wart hog, was a trypanosome found resembling the sleeping sickness trypanosome. Three of the animals were infected with a short active trypanosome of the *pecorum* type, while in the fifth a long thin trypanosome was observed. No trypanosomes were found in buffaloes.

BEDFORD (G. A. H.). **The Spinose Ear Tick (*Ornithodoros megnini* Dugès).**—*Union of South Africa. Dept. of Agric. Local Series No. 18.* 1917. July 12. 6 pp.

Reference is made to the above tick and the conditions set up by it in the appendix furnished by the Director of Veterinary Research in the Report of the Department of Agriculture. Union of South Africa, for the year 1916 [see this *Bulletin*, Vol. 6, No. 1, p. 59].

The tick is stated to be a native of South America and was probably introduced into South Africa with imported stock. The date of its first introduction is not known. It was first identified by THEILER at Vryburg in 1912, but it appears to have been observed in Cape Colony as far back as 1898. During the last few years it has become extremely common and widely distributed throughout the Cape Province, Orange Free State, and Bechuanaland, but to a far less extent in Natal. The ticks seem to be only found in districts where the rainfall is very low and even in these districts they appear to become less numerous after heavy rains.

The ticks chiefly infest the ears of cattle, sheep, and goats and more rarely they are to be found in the ears of horses, donkeys, dogs, cats, ostriches, and occasionally in man. Unlike all other ticks they are only found in the ears of their hosts and occasionally penetrate into the auditory meatus. The fluid injected by the ticks into their hosts while feeding causes great irritation and badly infected animals lose appetite and condition. Calves, sheep and goats have been known to succumb when severely infected. The ticks are not known to be able to transmit any disease.

The ticks belong to the family *Argasidae*, easily distinguished from the family *Ixodidae* (which includes the majority of ticks) by the entire absence of a dorsal shield or hard plate, which in the Ixodidae entirely covers the dorsal surface of the body of the male, and forms a small round plate just behind the head in the female.

"In general appearance they much resemble the Fowl Tick (*Argas persicus*, Oken) and the Tampan (*Ornithodoros moubata*, Murray). From the former they can easily be distinguished by their shape, and from the latter by the integument, which is pitted in *O. megnini*, and mammillated (covered with small pimples) in *O. moubata*.

"The *adults* are fiddle-shaped, brown or slate in colour, and their surface is pitted with small circular holes. The head is situated in front of the ventral surface; eyes absent; legs yellow.

"The males resemble the females, but are slightly smaller in size.

"The *nymphae* when engorged resemble the adults in shape and colour, but can at once be distinguished by the surface of their bodies, which are covered with small outstanding spines; these spines can be easily seen with the aid of a pocket-lens.

"The larvae when unengorged are extremely small, white in colour, and have only three pairs of legs, whereas the nymphae and adults always have four pairs of legs. After engorging they become swollen, white or red in colour, and their legs and head can only be seen when examined under a microscope. These engorged larvae are unable to move, and are often mistaken by the farmers for eggs.

"The *eggs*, like the eggs of other species of ticks, are extremely small, oval in shape, and reddish brown in colour.

"The life history. The female ticks lay their eggs under stones on the veld, in cracks and crevices of trees, gates, or walls, or on any other place where they can get sheltered from the sun. These eggs hatch out in about 22 to 56 days, and give rise to six-legged larvae, which as soon as they have hatched, crawl about in search of a host, and as soon as they find one they

get into its ears and there commence to feed. The longest time the larvae are able to live without food is about 2 to 4 months. After engorging, which takes about 5 to 7 days, they become quiescent, and are then unable to move until they have cast their skins and become nymphae. The length of time the nymphae remain on their host varies considerably. The shortest time in which they can engorge themselves appears to be about a week, but may be considerably prolonged in some cases. Hooker has observed a nympha to abandon its host's ear 35 days after the larva had been introduced, and in other cases a nympha remained attached after 98 days had elapsed. Nymphae have also been observed at Onderstepoort to remain in the ears of their hosts for three months. When engorged they leave their host and crawl about in search of some sheltered spot where they can change into adults, which takes from 7 to 31 days.

"They then fertilise, and then the females commence laying eggs, after which they die.

"It is not necessary for the adults to nourish themselves before copulating and ovipositing, as they are able to store up enough food in the nymphal stage. Engorged nymphae collected from the ears of their hosts in November, 1916, and kept in the Laboratory in wooden boxes moulted into adults in 7 to 9 days. A number of them died about 2 to 5 months after they were removed from their hosts, whilst others, including a male which fertilised a female soon after it had moulted into an adult, still remained alive after six months.

"Mégnin states that he has kept some *O. megnini* alive for two years without food."

With regard to measures for eradicating the ticks the most satisfactory methods to be employed are as follows :—

(1) The ticks may be destroyed on their hosts by pouring some insecticidal liquid into the affected ears ; the best preparation is made up of 2 parts each of Stockholm tar and oil to 1 part of turpentine ; from a teaspoonful to a tablespoonful is poured into each ear according to the size of animal to be treated, the mixture being well stirred before use. On badly infected farms it may be found necessary to treat the animals' ears every two or three weeks or even every week ; otherwise, they need only be treated once every month. Infected animals should be treated before removal from one farm to another.

(2) Preventive treatment may consist in either not keeping animals in kraals or in keeping them in non-infected kraals. The kraals generally in use, especially those made of stone and earth or cow-dung bricks, afford excellent breeding places for the ticks and are practically incapable of disinfection. In exceptional cases the interval between the nymphae of one generation leaving their hosts and the young larvae of the next generation may be quite two years, and thus infected kraals should be closed for at least that period. The animals may then be removed to kraals surrounded by a wire fence. Brushwood may be placed round the enclosure stacked up against the fencing to act as a protection against wind and rain. Such temporary enclosures can be easily taken down and removed from one part of a farm to another as it is not advisable to keep stock herded closely together on a small area too long.

According to the author it is strongly advisable not to keep the animals in kraals unless it is absolutely necessary but to turn them out on to the veld. In some parts of South Africa, however, it is not safe to leave sheep and goats on the veld at night on account of jackals. In this case they should be kept during the night in the tick-free enclosures referred to above.

RANSOM (B. H.). **Recent Progress in the Development of Methods for the Control and Treatment of Parasites of Live Stock.**—Paper presented before the Second Pan American Scientific Congress, Washington, U. S. A. Dec. 27, 1915–Jan. 8, 1916. 10 pp. 1917. Washington: Government Printing Office.

This paper is of interest inasmuch as the methods that have been employed for the eradication of the gross animal parasites in the United States are briefly reviewed and the possibilities of further success based on our present knowledge of the life histories of the parasites are discussed. The above measures are dealt with in the United States of America by a special section (the Zoological Division) of the Bureau of Animal Industry, and this section is under the control of the author.

As an indication of the work accomplished in that country by rational measures of control and treatment the following extract may be quoted :—

"The possibility of eradicating the Texas fever tick (*Margaropus annulatus*) became evident nearly a quarter of a century ago, when the principal facts in its life history were established, and somewhat later Curtice, Butler, and others furnished practical demonstrations by eradicating ticks from certain localities. It was not until 1906, however, that tick eradication was taken up in earnest on a large scale in the United States. The result of a little more than eight years work up to January 1, 1915, has been the release of about 225,000 square miles of formerly tick-infested territory from quarantine, nearly one-third the original quarantine area of about 730,000 square miles.

"Leaving out of consideration the question of improvements in administration, organisation, etc., the most important change in methods of tick eradication since the beginning of the undertaking has been the adoption of the arsenical dip as an agent for the destruction of ticks. Other remedies had for one reason or another proved partial or complete failures, but the arsenical dip after a number of modifications was found to be very satisfactory, and since it has come into general use eradication has progressed by leaps and bounds. Portable testing outfits for the rapid determination in the field of the percentage of arsenic in dipping baths have been recently devised, and have proved very useful in tick eradication work (Chapin 1914).

"The spontaneous oxidation and reduction of arsenical dipping baths reported by Fuller (1911) and others are phenomena of considerable practical importance as there is a difference in the efficacy of oxidised and unoxidised arsenical baths. For example, a bath containing originally a certain amount of arsenic in the form of sodium arsenite, may become more or less oxidised, with transformation of more or less of the sodium arsenite into sodium arsenate, which is less efficacious against ticks. Consequently, this bath might then fail to destroy ticks upon the cattle dipped in it. The field test, however, which shows the amount of arsenic present in the arsenite form, makes it possible to determine readily whether a given bath is up to standard in so far as the percentage of arsenite is concerned. Another question arises, whether a bath low in arsenite can be strengthened by adding enough fresh concentrated dip to bring it up to standard, without at the same time increasing the total amount of arsenic (arsenite+arsenate) to a point where it is dangerous to cattle. Recent experimental work has indicated that strengthening the bath in this manner may be done without injury to the cattle, even though the total amount of arsenic is raised much higher than it is ever likely to be in practice. The field test thus makes it possible to use the same dipping bath repeatedly, with the assurance that it will be at the proper strength each time it is used, more arsenic or more water being added according as the test shows the percentage of arsenic to be too low or too high.

"Comparatively little new has been added recently to our methods of handling scabies. Field-testing outfits for lime-sulphur and nicotine

dipping baths, the two most efficacious remedies for scabies of cattle and sheep, promise to be as useful as the testing outfit for arsenical baths (Chapin, 1915). In connection with sheep scab it is of interest to note that Wolffhügel (1913) has called attention to the occasional persistence of scab mites in the ear and infraorbital groove of sheep which have been dipped, and has suggested that many failures to cure scab may be traced to this circumstance."

Other conditions such as those caused by warble flies (*Hypoderma bovis* and *H. lineatum*), *Dermatobia noxialis*, and the screw worm (*Chrysomyia macellaria*) which may also be controlled by the application of arsenical dips are considered.

Dealing with helminth infestations the author does not hold forth much hope of evolving a satisfactory method for controlling by preventive measures the serious losses caused by stomach worms (chiefly *Haemonchus contortus*) in sheep. Many of the details of the life history of these worms have been determined. The eggs of the parasites during the summer months hatch in a few hours and the larvae develop to the infectious stage within a week after the eggs are dropped on the pasture. In this stage they are very resistent, and may be frozen repeatedly and kept in a dried condition for long periods of time without losing their vitality. A field vacated for seven months, from October to June, was found still to contain living larvae when tested by placing non-infected lambs in it. The adult worms may live many months in the stomach of their host and have been found still present in small numbers in sheep kept a year and a half on a board floor and handled in such a manner that the chance of fresh infection was reduced to a minimum.

"In view of the various difficulties that stand in the way of preventing infection with stomach worms, the problem of control is apparently a hard one. Fortunately there are various medicinal remedies which are more or less efficacious against stomach worms, and if satisfactory rotation methods can not be discovered it is likely that a practical solution of the stomach-worm question may be accomplished with the aid of some sort of medicinal treatment, just as the use of arsenical dips has proved to be the solution of the tick-eradication problem. Considerable work on a small scale has already been done in the Bureau of Animal Industry upon the question of controlling stomach worms, and recently more extensive investigations have been undertaken, with the inauguration of experiments to be carried on under approximately practical conditions upon a farm of 160 acres leased for the purpose near Washington."

The following again is a matter of interest :—

"With reference to the various species of parasites of live stock for whose prevalence the nuisance of unrestricted dogs is responsible, and whose control depends upon properly controlling dogs, it is of interest to note that another parasite has recently been added to the list by the discovery (Ransom, 1912; 1913) that the muscle cysticercus of sheep known as *Cysticercus ovis* is the intermediate stage of a previously unrecognised tapeworm of the dog (*Taenia ovis*). This parasite is very common in the United States and probably also in other countries. During the last fiscal year 39,639 sheep carcases out of a total of 12,909,089 slaughtered under Federal inspection were retained on account of infestation with this parasite—about 0·3 per cent. Owing to the difficulty of discovering the parasite many cases of infestation are undoubtedly overlooked, and the percentage of sheep infested is probably much greater than that given."

Imes (Marion). **Sheep Scab.**—*U. S. Dept. Agric. Farmers' Bull. 713.* 1916. Apr. 17. 36 pp. With 21 figs. 1916. Washington: Government Printing Office.

—— **The Sheep Tick and its Eradication by Dipping.**—*Ibid. Bull. 798.* 1917. May. 31 pp. With 15 figs.

—— **Cattle Lice and How to Eradicate Them.**—*Ibid. Bull. 909.* 1918. Feb. 27 pp. With 14 figs.

These publications of the Zoological Division of the United States

Bureau of Animal Industry contain a very large amount of concise information regarding the skin parasites mentioned above, together with methods for their eradication. This information is, however, mainly intended for the use of laymen, and is of an elementary nature, but as the method of dipping for the control of ectoparasites has now been practised with success on such a large scale in the United States it is considered, judging from the experience that must have been gained, well worth reproducing some of the plans given for the construction of cattle and sheep-dipping plants.

The figures reproduced on following pages are those of the plants with concrete or cement vats recommended for cattle and sheep and of the plant with wooden vat for cattle; the following details with regard to the construction of the cattle dipping vats are reproduced.

"The dipping vat may be constructed either of cement or of lumber—the cement vat being preferable, as when properly made it is more durable and in many other ways more satisfactory than a wooden vat. The sides may be perpendicular, as shown in the plans for a cement vat (fig. 11), or sloping, as shown in those for a wooden vat (fig. 10). Sloping sides are generally considered more desirable than perpendicular ones for either cement or wooden vats. Both styles, however, are shown in the drawings, because some stockmen prefer vats with perpendicular sides. The dimensions shown in the cross section of the wooden vat may be followed in constructing a cement vat with sloping sides.

"The length of the vat may vary from 24 to 100 feet, depending on the number of cattle to be dipped. The top may extend 9 to 18 inches above the surface of the ground or may be flush with it. A vat of the former kind affords better conditions for handling the cattle than one of the latter kind. If it is desired that the top be flush with the ground, the vat should be built so that it extends 5 inches above the natural surface of the ground, which is then graded up with gravel or cinders and a dry path along each side of the vat thus provided.

"The slide board should be made of or covered with a smooth-surfaced material, such as planed lumber or sheet metal. A piece of boiler plate makes an excellent slide board. The dimensions of the slide board shown in connection with the cement vat are those commonly used. A short, steep slide board causes the animals to plunge abruptly into the dip, while a long gradual slope allows them to slide in more gently. The short, steep slope has the advantage that the animals cannot brace themselves on it for a leap as easily as on the long, gradual slide.

"The exit incline or crawling board in small vats should be about 16 feet long, so that the incline may not be too steep. In cement vats a false floor to which the cross cleats are nailed is usually laid on the exit incline. Bolts should be embedded in the concrete for fastening the false floor. The plans for the concrete vat show the lower end of the floor held in position by a cross pipe embedded in the concrete and the upper end and middle held by bolts.

"If permanent pipes are used for conducting water and dip to the vat they should be laid so as not to act as obstacles to the men working along the vat. There should be no obstruction in the path along both sides of the vat; neither should there be any cross pieces over the top of the vat that may interfere with the proper handling of the cattle while they are in the dip.

"The wooden vat shown in the plans has sloping sides, but, as already stated, they may be made perpendicular if desired. When soft wood is used for the frame timbers they should be 6 by 6 inches, but if hard wood is used 4 by 4 inch timbers are sufficiently large for the purpose. Cedar posts make good framing timbers, as they do not rot rapidly. Matched planks 2 inches thick should be used in building the vat, and they should be bevelled so that all joints and seams may be properly caulked with oakum and rosin or similar material.

"A water trap with hinged cover is shown in the exit incline of the wooden vat. While dipping is in progress both the cover and the valve to

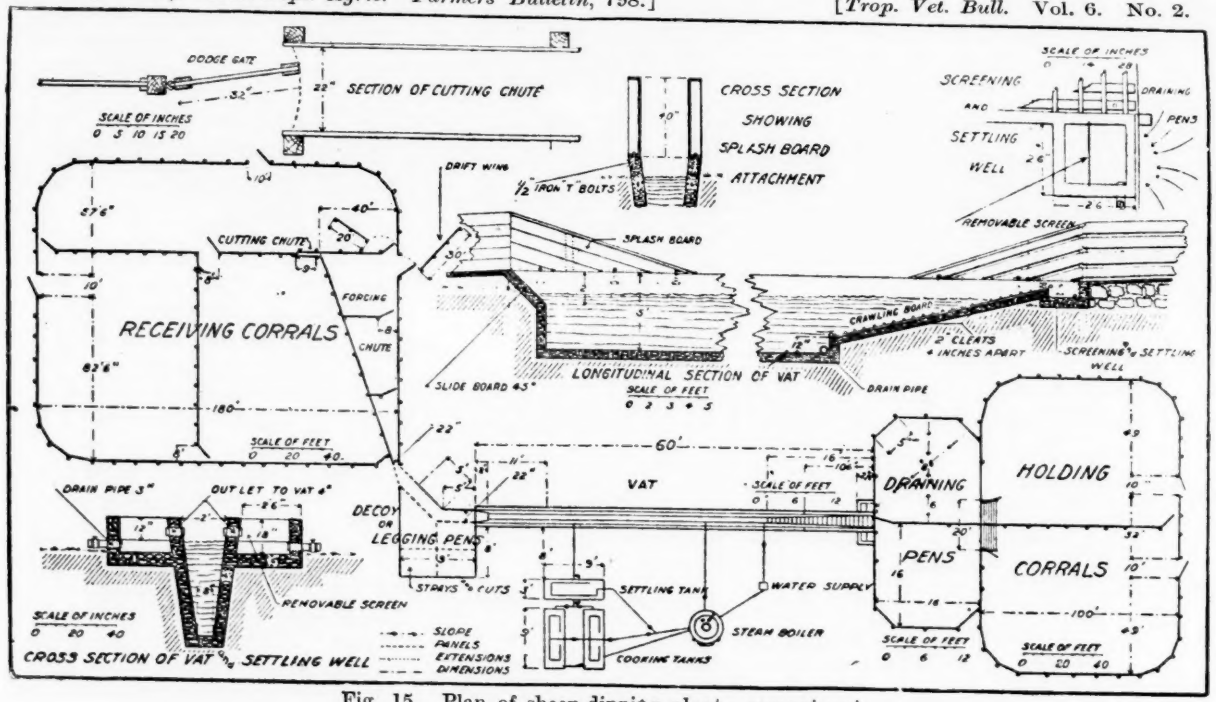


Fig. 15. Plan of sheep-dipping plant; cement vat.

[Reproduced by permission of the United States Dept. of Agriculture.]

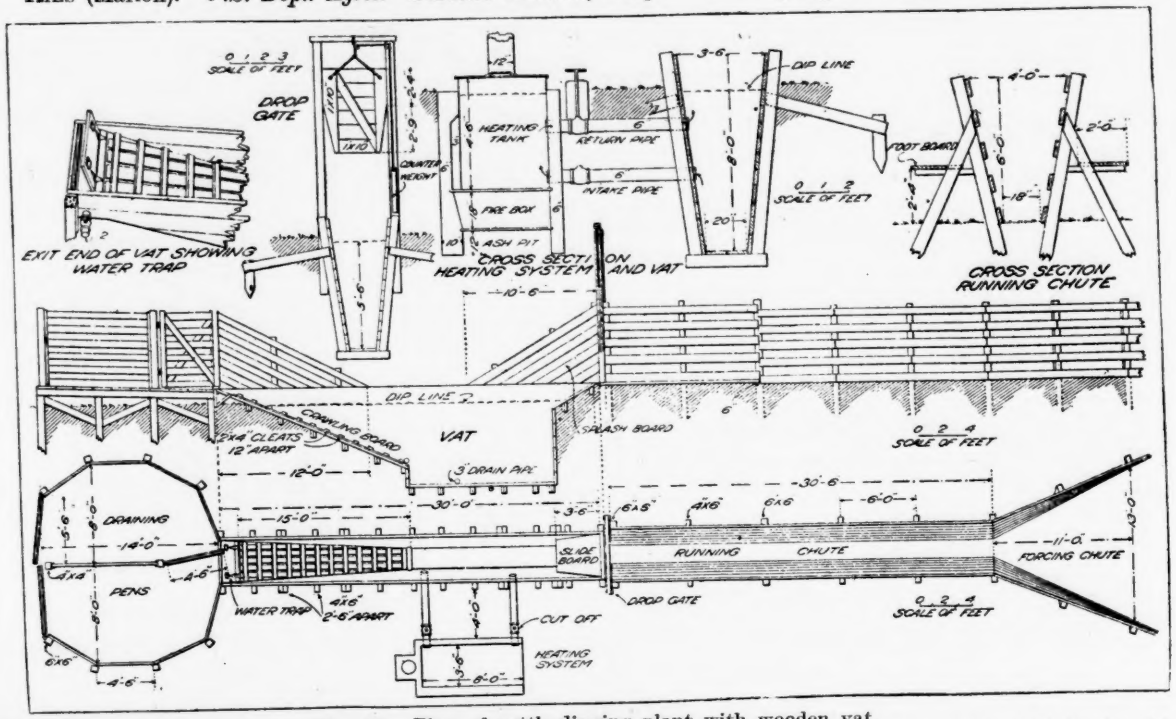


Fig. 10. Plan of cattle-dipping plant with wooden vat.

[Reproduced by permission of the United States Dept. of Agriculture.]

Fig. 10. Plan of cattle-dipping plant with wooden vat.
[Reproduced by permission of the United States Dept. of Agriculture.]

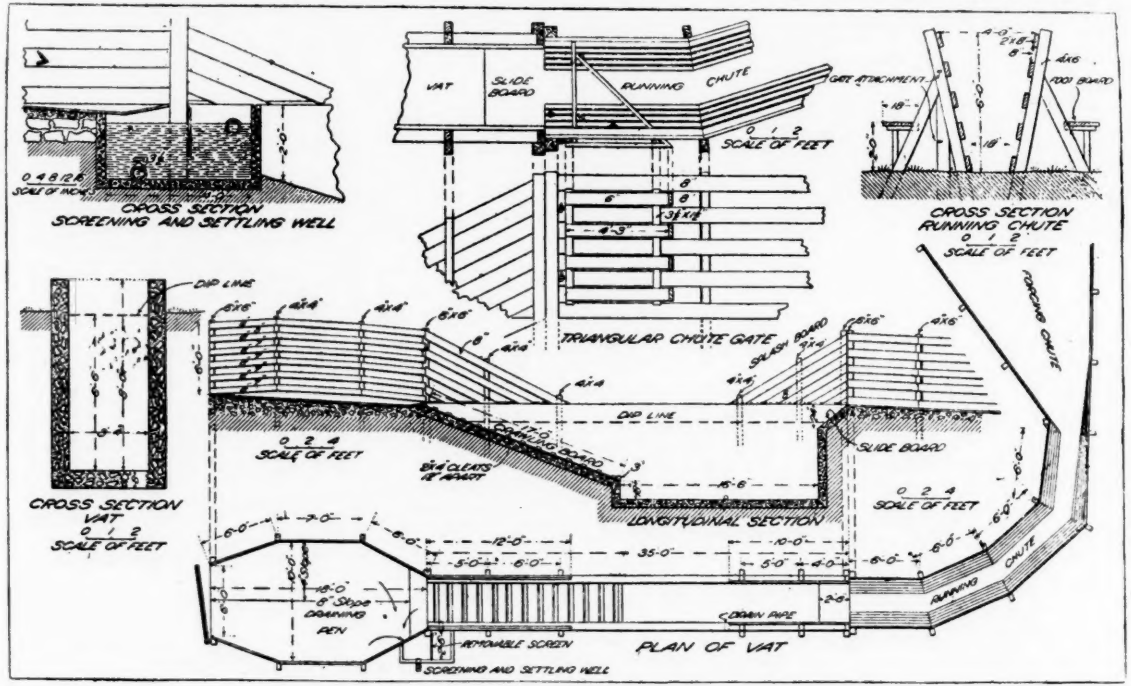


Fig. 11. Plan of cattle-dipping plant with concrete vat.
[Reproduced by permission of the United States Dept. of Agriculture.]

the drain pipe should be closed, but when dipping is finished for the day both should be opened so that water from the draining pens in case of rain may not run into the vat and dilute the dip.

"Heating equipment is necessary in the case of those dips which are used warm. That shown in the plans of the wooden vat may also be built in connection with a cement vat. When the open-tank heating system shown in the plans is used settling wells are not necessary, as the heating tank answers the purpose of a settling well. This system has an advantage over the old-style coil heater in that the pipes may be easily kept from clogging. Another method of heating, and the one usually employed, is to install a 25 horsepower boiler and to pipe the steam to the vat, where it discharges into the dip through perforations in a pipe laid along the bottom of the vat for about two-thirds its length. The water condensing from the steam passing into the vat from the boiler dilutes the dip to a slight extent, and for this dilution an allowance should be made in replenishing the dip.

"The trench for the vat should be excavated so that the inside dimensions correspond with the outside dimensions of the completed vat. If the sides of the trench are reasonably firm they may be used for the outer walls of the form, but in all cases where the vat is extended above the surface of the ground it is necessary to build forms extending from the ground surface to the top of the vat. If the soil is sandy or the walls cave in it will be necessary to use outer forms, in which case the trench should be wide enough to allow for these forms.

"The forms usually are made of 1 inch boards and 2 by 4 inch braces, but as a supply of 2 inch lumber is necessary for the corrals and chutes, some of this lumber may first be used for the forms and afterwards for constructing corrals and chutes. . . .

"Bolts for fastening the crawling and slide boards and the drain and other pipes should be placed in position in the forms before the concrete is laid. The concrete side and end walls may be reinforced with heavy woven wire, in which case the reinforcements should be placed properly in the forms so that they may be embedded in the middle of the walls.

"The concrete for dipping vats should be made of 1 part of Portland cement by measure, 2½ parts of sand, and 4 parts of screened gravel or crushed stone. The sand should be coarse, clean, and free from foreign matter. The crushed stone or gravel may vary in size from one-quarter to 1 inch in diameter. The mixing should be done on a smooth, tight, platform and the sand and rock measured separately in a bottomless box 2 feet long, 2 feet wide, and 1 foot deep, having a capacity of 4 cubic feet. For 2½ cubic feet mark the inside of the box 7½ inches up from the bottom. Each sack of Portland cement is considered equal to 1 cubic foot. Mix thoroughly the sand and cement, add the crushed stone (previously drenched with water), and mix the whole mass by turning it several times with shovels. Then add water in a depression made in the centre of the pile and mix well by turning several times with shovels, adding sufficient water during the mixture to make a quaky or thin jelly-like mixture.

"The placing of the concrete in the forms should be commenced as soon as the mixing is finished. The floor and exit end should be laid first and the concrete well tamped. In filling the forms the concrete should be settled into place by spading rather than tamping, and special attention should be given to spading next to the inside forms to force back the coarse particles and allow the sand-cement mortar to form a dense, water-tight surface. An old hoe straightened out makes a good spading tool, as the handle is long enough so that the bottom of the forms may be reached. If it is necessary to stop work for the day before the forms are filled, the surface of the concrete in the forms should be roughened with a stick. Just before placing additional concrete wash the roughened surface and paint it with cement and water mixed to the consistency of thick cream. Leave the forms in place two or three days, if possible, and wet the concrete daily. After the forms are removed, dampen the surface of the concrete and apply a finishing coat composed of 1 part of cement and 2 parts of sand, or mix cement and water to the consistency of cream and apply it, brushing well to form a smooth surface."

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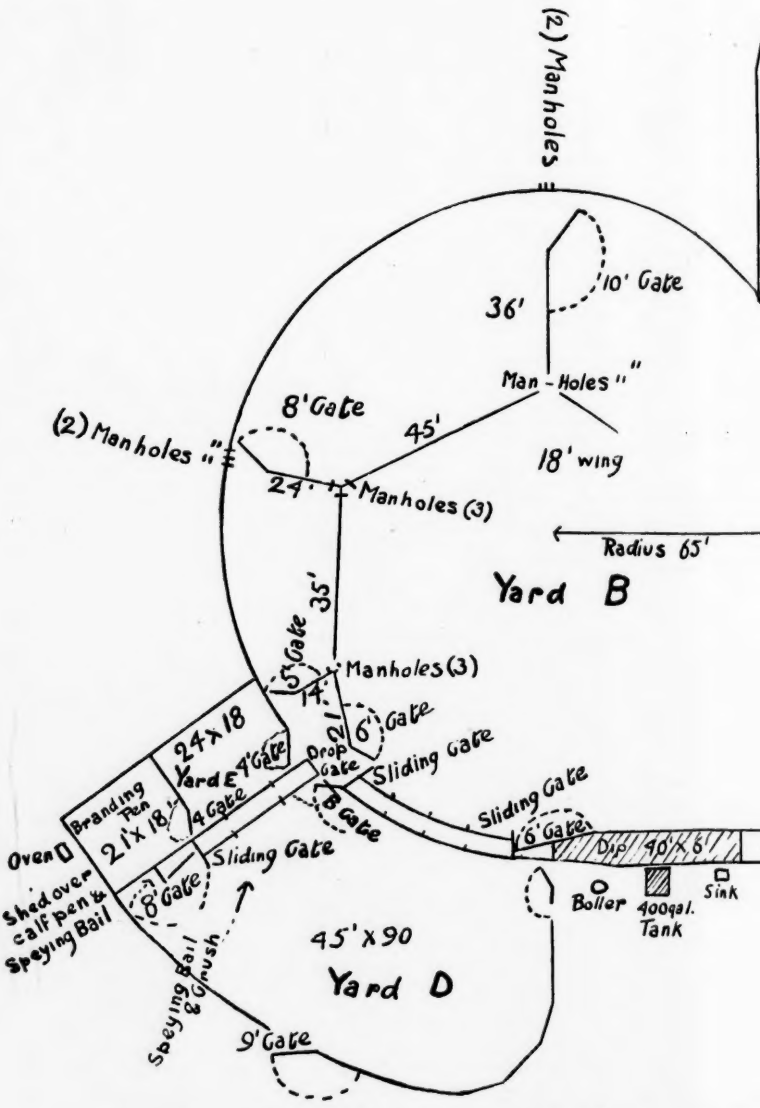
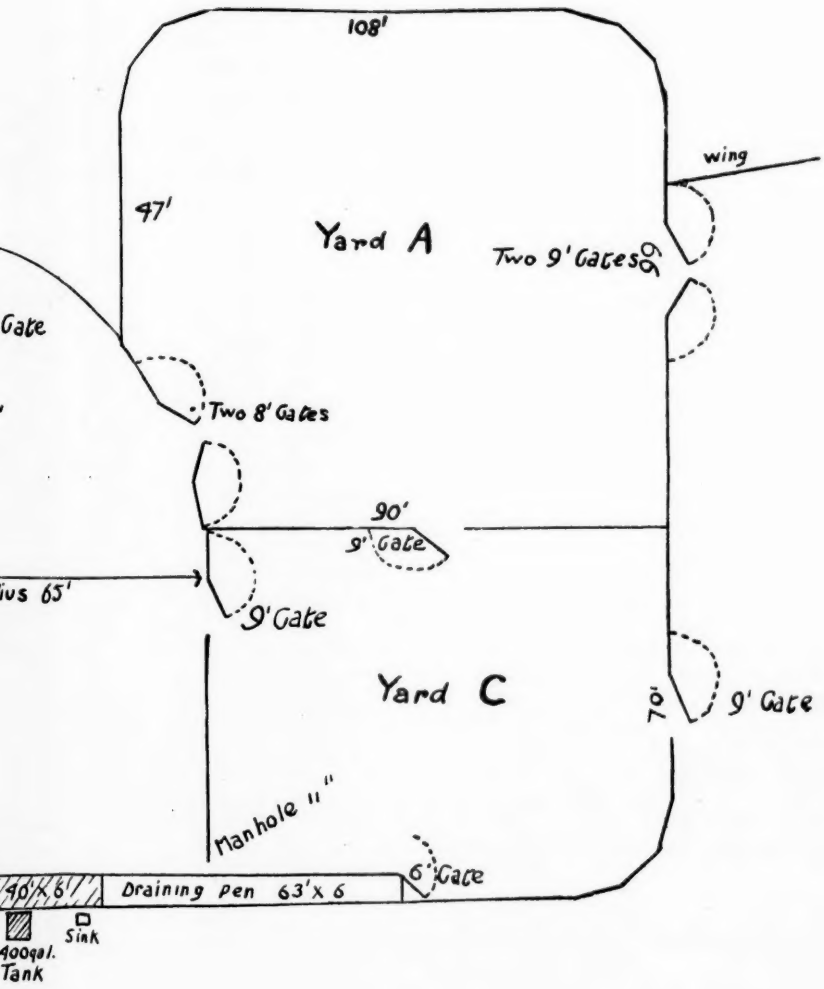


Ground Plan of Cattle Yards and Dip for Branding, Weaning, Sp

When the Yards are only required for Dipping, Yards D and E
Yards A and C may al



, Weaning, Speying, Inoculating, and Dipping; to hold 800 Head.

rds D and E are omitted. For dipping small numbers of Dairy Cattle, and C may also be omitted.

[Reproduced by permission from the *Queensland Agric. Jl.*

WHITE (E. E. D.). **Dipping Cattle.**—*Queensland Agric. Jl.* 1917. Oct. Vol. 8. Pt. 4. pp. 207–209. With 1 plate.

This short article is held to convey " the opinions of an experienced stockman on an unfenced holding carrying 17,000 cattle and working eight dips " in North Eastern Queensland.

The losses among cattle due to ticks (*Margaropus annulatus australis*) when they first appeared in that region 20 years ago amounted to 60 per cent. At present the progeny of those cattle in this badly infested territory have acquired an immunity towards diseases transmissible by ticks, but the losses caused by tick irritation are not generally realised, and are said to amount to 80 per cent. of the total female cattle branded each year. Although present conditions preclude the idea of eradicating the ticks the author suggests that in view of the loss of condition now caused their suppression by means of systematic dipping must be regarded as the best possible investment for the cattle owner.

In the dipping of cattle attention should be paid to the following points. The dipping tank should be 6 feet wide in order to reduce the risk of cattle injuring each other and should be provided with a long incline and wide steps at the exit to assist the movement of weak cattle. The draining yard should be long and from 8 to 12 feet wide. The dipping tanks should be distributed so that cattle need not be driven more than 7 to 8 miles. The frequency of dipping must depend on the nature of the country. In certain parts it was found necessary to dip every three weeks throughout the year, while in other areas an occasional dipping suffices. In the tableland country it was found best to perform dipping operations from April to July for during that period the grass is good, the cattle strong, the weather cool, and the ticks, if unchecked, are increasing at a rapid rate ; one dipping at this time is worth more than four in August (in Australia). It has often been stated that weak cattle and fattening bullocks should not be dipped but the author's experience indicated that in both cases dipping resulted in improved condition ; it was found advisable not to put cattle on the road for at least five days after treatment. Calves were dipped from two weeks of age upwards, but the strength of the dip should be less than the accepted standard in their case to avoid any risk of loss.

SINCLAIR (J. M.). **Management of Dipping Tanks.**—*Rhodesia Agric. Jl.* 1918. Feb. Vol. 15. No. 1. pp. 32–33.

" In a paper entitled ' Notes relating to Arsenical Dipping Fluids,' by Mr. A. G. Holborow, F.I.C., Assistant Agricultural Chemist, which appeared in the December, 1915, issue of the *Journal*, it is stated that ' it should be an easy matter, knowing the volume of liquid in the tank and the exact strength of it, to rectify any deviation by adding water only, or dip, as the case may be, and bring the dipping fluid to any desired strength.' The writer agrees entirely with this view, but his experience shews that many owners and managers of tanks find a considerable difficulty in doing so. In some cases the reason is that the capacity of the tank inch by inch is not known, or, if known, is not made use of in calculating the quantity of water or dip required

to bring the liquid in the tank to the proper strength. In other cases, the quantities are calculated in a haphazard or crude manner, with the result that the strength may be so increased as to cause damage to the cattle, or so diminished as to be ineffective. The tendency in the majority of cases is in the latter direction, probably because the persons concerned, not being quite sure of their quantities, prefer to err on the side of safety.

"The following notes on the management of the dipping solution and dipping tanks generally will, it is hoped, be of some assistance to stock owners.

"1. At the first filling the water should be measured into the tank by a 200 gallon or other convenient measure.

"2. From the 3 feet 6 inches level the volume, inch by inch, should be carefully recorded and marked on the wall of the tank, or preferably on a measuring rod, which can be obtained at a small cost.

"3. The level should be recorded after each dipping and again before the following one.

"4. Any decrease due to evaporation should be replaced by water only.

"5. Any increase due to rain or flood water should be made up to standard strength by the addition of the corresponding quantity of dip.

"6. When a sample is taken for analysis the quantity of solution in the tank at the time should be accurately estimated, otherwise it is impossible to rectify any excess or diminution of strength shewn by such analysis.

"7. The following example is given of correcting the strength of the solution in the tank on receipt of the result of the analysis :—

"(a) capacity of tank at proper dipping level—3,000 gals. ;

"(b) prescribed strength of dip used—say, 1 to 150 gals. of water ;

"(c) quantity of solution in tank at date sample was taken—say, 2,400 gals. ;

"(d) assume analysis shews strength—1 in 200 ;

"(e) then the 2,400 gallons in tank contain 12 gallons of dip only, instead of 16 gallons ; therefore, 4 gallons of dip must be added to bring the solution up to proper strength ;

"(f) there remain the 600 gallons of water required to bring the volume in tank up to the proper dipping level ; this requires another 4 gallons of dip ;

"(g) the total quantity of dip, therefore, which is required to rectify the diminished strength of the solution in the tank, and provide for the 600 gallons of additional water added to the tank, is 8 gallons.

"8. Where necessary, the tank should be protected by drains, to prevent the dip being flooded out on to the surrounding veld.

"9. When not in use, the entrance and exit of kraals and draining pens should be properly secured.

"10. The draining pens should be so constructed that dip cannot collect in them.

"11. The drums, whether closed or not, containing the concentrated dip should be kept under lock and key.

"12. When emptied, the drums should be immediately and thoroughly washed, and the washings placed in the tank or buried.

"13. Where kraals are used in addition to draining pens, in order to allow cattle to drip and dry completely, cattle should not be allowed into them until any water which may have collected in pools has been dispersed.

"In forwarding samples of dipping solutions for analysis, the greatest care should be taken to ensure that the bottles in which they are forwarded, and the utensils used for filling the bottles, are absolutely free from extraneous arsenic."

JARVIS (E. M.). **Report on Ixodic Lymphangitis (German East Africa Campaign, 1916-1917) made to the A.D.V.S., Dar-es-Salaam.**—*Vet. Jl.* 1918. Feb. Vol. 74. No. 2. pp. 44–53.

In this paper the author gives a somewhat loose description of a number of conditions resulting from secondary infection of the wounds caused by the bites of ticks of the species *Amblyomma variegatum*. The animals affected are horses, mules, asses, and more rarely cattle and sheep; the symptoms and lesions which may occur on the lower part of the limbs, on the body, or may be confined to the skin are of a very acute or of a chronic character according to the type of organisms introduced. These organisms include the Preiz Nocard bacillus, *Cryptococcus farciminosus* (occasionally), the necrosis bacillus, staphylococci, and other organisms. Numerous cases of the disease were observed by the author in Southern Rhodesia, but it seems to have disappeared from that country since measures were taken for the eradication of the tick. In East Africa a certain proportion of cases may be caused through the agency of Stomoxys.

SIGWART (Hans). **Beitrag zur Zeckenkenntnis von Deutsch-Südwest-afrika, unter besonderer Berücksichtigung der Funde in den Bezirken Outjo und Waterberg.** [The Ticks of German South West Africa, with Special Reference to those found in the Districts of Outjo and Waterberg.]—*Ztschr. f. Infektionskr. . . . d. Haustiere.* 1914–1915. Vol. 16. No. 6. pp. 434–444. With 1 map & 6 text-figs.

The author's investigations were carried on from September 1912 to May 1914. It appears that the climatic conditions of what was formerly German South West Africa are not very favourable for the rapid multiplication of ticks. The rainy season is sharply differentiated from the dry season. The rains lasted in the districts visited from about the beginning of December to the end of April and the rainfall varied from 100 to 700 mm. After this period of excessive moisture the ticks have to face a dry period of from six to seven months with nocturnal temperatures often below 0° C. Thus during the months in which the ticks were most numerous (February to April) they were by no means obvious on any of the domesticated animals and could only be found in considerable numbers within the ears, in the inguinal region, or around the genital organs. From May till September the domesticated animals and wild game are often found to be quite free of ticks. The author gives a list of the ticks found together with their morphological characters and prevalence. The species found were as follows:—

(a) Argasidae: *Argas persicus*, found in abundance in most fowl houses.

(b) Ixodidae: *Aponomma exornatum*, found in one locality.

Hyalomma aegyptium, or spotted-legged tick; this is by far the most common tick and was found in every district visited; it was found, but only in the adult stage, on equines including zebras, cattle, sheep, goats, oryx antelopes, small antelopes, wild pigs, and also on the dog and man. This tick is of great importance on account of its capacity of acting as a transmitting agent of redwater in cattle.

Rhipicephalus evertsi var. *mimetica* Dönitz, a tick showing an extraordinary resemblance to *Hyalomma aegyptium* in shape and colour, but somewhat smaller in size. It would be a matter of interest to determine whether this variety of *R. evertsi* is capable of acting as vector of East Coast Fever. This fairly common tick was found on horses, cattle, sheep, and goats; nymphs were also taken from cattle.

R. oculatus, a widespread tick found especially in considerable numbers on hares; other hosts in order of decreasing importance were the small antelopes, the sheep, the goat, the dog, equines including zebra, and cattle. The predilection seat of the tick was within or in the neighbourhood of the ears and on those parts of the body covered with thin skin. The larger animals were seldom infected. Nymphs were found on a dog and an ox.

R. sanguineus was found in two localities and the hosts included equines, wild pigs, the sheep and dog. The dog appeared to be the favourite host.

Rhipicentor bicornis and *Haemaphysalis leachi* were found to infest canine animals only and the latter tick especially was of very rare occurrence.

YAKIMOW (W. L.), SCHOCHOS (N. I.), KOSELKIN (P. M.), WINOGRADOW (W. W.) & DEMIDOW (A. P.). **Die Mikrofilariose der Pferde im Turkestangebiete.** [Equine Microfilariasis in Turkestan.]—*Ztschr. f. Infektionskr. . . . d. Haustiere.* 1915. Vol. 16. No. 4. pp. 275–286. With 1 text-fig.

Yakimow and his assistants discovered that among certain military units in Turkestan the horses were found to harbour microfilariae in their blood in proportions varying from 0·53 to 37·6 per cent. Civilian horses were also examined and the proportion of infected animals varied from nil in the case of animals slaughtered at Taschkent slaughterhouse to 8·1 per cent. in a certain township. The horses belonging to the military units affected most considerably were in poor condition and a characteristic symptom among infected animals was the presence of abrasions on the skin due to irritation, especially around the nostrils. Sometimes oedematous swellings were observed on the chest, belly and limbs. In some cases the horses showed rapid exhaustion and dyspnoea on being put to work.

The haemoglobin content of the blood fell in some cases down to 60 per cent. and there was marked eosinophilia (up to 11·7 per cent). There was sometimes an increase in the percentage of lymphocytes (up to 48·8 per cent.) whilst the polynuclear neutrophiles showed a corresponding decrease (down to 40 per cent). Myelocytes and transition forms were also sometimes seen.

The microfilaria possessed an elongated cylindrical body gradually tapering towards its posterior extremity; the anterior end was rounded. The whole body was surrounded with a thin transparent cuticular sheath projecting some distance beyond the extremities of the nucleated column. The nucleated column usually showed three clear spots situated at distances of 5·68—10·65μ, 38·34—52·25μ, and 142—172, respectively, from the anterior end. The nucleated body stained of a blue or violet-blue colour with Giemsa while the sheath stained pink or remained colourless. The length of the parasites was

as follows;—without sheath 158·98—266·96μ, with sheath 270·45—323·76μ; the breadth was, without sheath 4·26—9·94μ, with sheath 7·10—11·36μ.

No diurnal periodicity was observed. The authors failed to infect a horse, an ass, and two sheep by subcutaneous injection of blood containing numerous microfilariae. Intravenous injection of salvarsan produced no diminution in the number of parasites in the blood.

The authors state that the microfilaria observed by them bore considerable resemblance to the parasite discovered by MANDEL (1910) in the blood of horses in Germany and also to the embryos of *Filaria equina* Abildgaard, 1789 (=*F. papillosa* Rudophi, 1802), the filaria commonly found in the peritoneal cavity of equines. MANDEL, however, described the occurrence of albuminuria in his cases, whereas this symptom was absent in the horses examined by Yakimow. Inasmuch as the blood parasite appeared to differ from the microfilariae already described in the literature the authors propose the name *Microfilaria ninae kohl-yakimovi* for it. [For further details in connection with microfilariae of horses see WIRTH (this *Bulletin*, Vol. 5. No. 4. p. 237).]

STEWART (F. H.). i. **On the Life-History of** *Ascaris lumbricoides.* Preliminary Note.—*Brit. Med. Jl.* 1916. July 1. No. 2896. pp. 5–7. With 4 text-figs.

ii. **Further Experiments on Ascaris Infection.**—*Ibid.* 1916. Oct. 7. No. 2910. pp. 486–488.

iii. **On the Life-History of** *Ascaris lumbricoides.*—*Ibid.* 1916. Dec. 2. No. 2918. pp. 753–754.

iv. **On the Development of** *Ascaris lumbricoides* **Lin. and** *Ascaris suilla* **Duj. in the Rat and Mouse.**—*Parasitology.* 1917. Feb. Vol. 9. No. 2. pp. 213–227. With 1 plate comprising 12 figs. & 9 text-figs.

v. **On the Development of** *Ascaris lumbricoides* **and** *A. mystax* **in the Mouse. Part II.**—*Ibid.* 1918. Jan. Vol. 10. No. 2. pp. 189–196. With 1 plate.

vi. **On the Life-History of** *Ascaris lumbricoides* **L.**—*Ibid.* pp. 197–205.

Although the importance and ubiquity of Ascaris infection in man and the lower animals are universally recognised very little appears to have been added to our knowledge regarding the life-history of these round worms since the work of the earliest observers. The above articles written by Stewart thus comprise contributions of great general interest.

The following account of the small amount of literature on the subject is taken from the author's preliminary note.

"The development of *Ascaris lumbricoides* is at present almost universally considered to be direct. It is well known that the eggs passed in the faeces of man undergo development in the outer world up to the formation of a motile vermiform embryo. The egg containing this embryo may readily reach the alimentary canal of man, and it is supposed that it there hatches, and that the larva, having escaped, develops in this site into the adult. This theory is based on the work of Davaine (1859–1863), Grassi (1887–1888), Calandruccio (1886), Lutz (1887–1888), Epstein (1892), Jammes & Martin (1896–1908), Martin (1913), and Wharton (1915). . . .

"Davaine administered ripe eggs to rats, and found that after 12 hours free live larvae were to be found in the lower part of the small intestine. He also introduced ripe and unripe eggs in glass capsules closed with linen into the alimentary canal of a dog and found that after the lapse of a certain period the ripe eggs had disappeared, whereas the unripe eggs remained. He concluded that hatching and development occurred in the alimentary canal of the definitive host.

"Grassi administered ripe eggs to himself, and two months later found eggs in his stools. Calandruccio infected a child of 10 which had previously suffered from worms, but had been relieved of these parasites by anthelmintics. Lutz fed an adult on ripe eggs, and found evidence of the subsequent appearance of adult worms. Epstein's work is unfortunately not available even in summary, but from the context of the references it is clear that he successfully infected man.

"Jammes and Martin worked on the line of experimental hatching of ripe eggs in artificial and natural solutions, and found that hatching took place readily and *en masse* in 0·8 per cent. salt solution (which they consider to be an alkaline solution) at 37° to 40° C. Martin found that the embryos of the ascarids from the calf, pig, horse and dog hatched best in alkaline solutions, and that when developed eggs were introduced into the alimentary canal of an animal they passed through the stomach unaffected, and only hatched after they had been subjected to the action of the alkaline juices of the intestine. . . .

"Wharton states that direct infection can take place, but that the embryos must be 'completely developed.' He does not give the period necessary to secure this complete development.

"In spite of the general acceptance of the theory there is a considerable bulk of evidence against it.

"Davaine administered three to four hundred ripe eggs to an ox—an animal which is stated to harbour *Ascaris lumbricoides*—and found that after four months no worms were present in the intestine. Küchenmeister experimented with a dog, which, however, escaped from his observation. Leukart (1867) fed a rabbit on ripe eggs, and found no worms after ten days; a dog was also treated, and was equally unresponsive after 14 days. This very experienced helminthologist also fed a pig for three weeks on several thousand ripe eggs, and did not find any worms on section. An experiment on man was arranged in 1857, but it is not clear that it was carried out. He also administered to a horse the eggs of *Ascaris megalocephala*; to a dog those of *Ascaris marginata*; to a cat those of *Ascaris mystax*, with invariably negative results.

"Leukart, therefore, maintained that the life history of *Ascaris lumbricoides* would be found to be completed by an alternation of hosts. He supported this opinion by the facts known with regard to (1) *Ascaris acus*, which is found as an encysted larva in *Leuciscus alburnus*, and in the adult form in the pike, and (2) a larval *Ascaris* found encysted in the muscles of the mole, which, when administered to the buzzard continues to develop, although it does not yet become adult. He considered that Davaine's rat experiment, if correctly described, did not point to the direct development of the worm, but to the fact that the rat was an intermediate host. He pointed out the ease with which the larvae liberated in the faeces of the rat could be conveyed to the intestine of the definitive host—man. He attempted to confirm the experiment, but employed a mouse in place of a rat, and found that the eggs were passed unaltered in the faeces of the mouse. He therefore abandoned this line of research. He attempted to find the intermediate host among invertebrate animals, experimenting with a number of insects, snails, and earth worms, but without success. Von Linstow (1886) suggested that *Julus guttulatus* might be the intermediate host."

Stewart's experiments which were commenced in the spring of 1915 were carried out in Hong Kong, in which Colony and in Southern China generally ascariasis both in man and the pig is of extraordinary frequency. He later adds that "there is reason to suppose that a great deal of the debility of the natives of the tropics is due to

ascariasis, and that this disease is at least equal to ankylostomiasis in economic importance."

Some preliminary experiments performed on the pig by feeding it with large quantities of ripe Ascaris eggs gave wholly negative results, thus confirming LEUKART'S experiment with the same animal, and furnishing strong evidence that the whole development did not take place in the definitive host. In order to ascertain whether the worm underwent a portion of its life cycle in an intermediate host DAVAINE'S experiment with the rat was taken up, and as a result of a number of carefully performed researches some very interesting observations on the migration of the worm in this animal and in the mouse were made. These results are summarised as follows :—

"When eggs of *Ascaris lumbricoides* Lin. or *A. suilla* Duj. containing mature embryos gain entrance to the alimentary canal of the sewer rat, *Mus decumanus*, or the mouse, *M. musculus*, they hatch. It is not possible to say at present in what part of the alimentary canal hatching takes place. (The number of animals suitable for experiment at the disposal of the writer is unfortunately so small that he is unable to devote any of them to the working out of the details of the process.) A certain proportion of the larvae thus liberated escape in the faeces where under suitable circumstances they can live for at least three days. It is, however, probable that they ultimately succumb and that this is not the true mode of development.

"The majority of the larvae gain entrance into the body of the host. The exact point of entrance and the time after hatching at which entrance takes place have not been determined. Some animals show signs of illness on the second day after infection. The time elapsing between infection and the entrance of the larvae into the body is therefore probably not more than two days.

"Larvae are found in the lungs and liver of the host not later than four days after infection and possibly as early as two days. Sections of the tissues show that they are situated in the air vesicles of the lung and in the blood capillaries of the liver close to the interlobular branches of the portal vein.

"Larvae are not found in the liver after the fifth day from infection. They are found in the bronchi about the seventh day and in the trachea on the eighth day.

"No larvae are found in any portion of the lung on the ninth day after infection. Dead larvae have been found in the stomach and rectum on the ninth day after the last infection.

"The route by which the larvae reach these sites is of course not definitely proved but from anatomical considerations it is hardly possible that it can be other than one of the two following (the diameter of the larva is three times that of a red blood corpuscle of the mouse. The larva could therefore not pass through the lumen of an ordinary capillary vessel) :

"(1) Boring through the wall of the stomach or intestine the larva enters a mesenteric venule and is carried to the liver. It is here arrested at the entrance to the hepatic capillary plexus and it is for this reason that so many larvae are found in the capillaries close to the interlobular veins. The liver undergoes extreme and acute fatty degeneration so that the larvae are able to penetrate along the capillaries between the degenerated columns of liver cells into the hepatic venules. Thence they pass in the hepatic vein to the heart and by the pulmonary artery to the lung. They are of course at once arrested by the pulmonary capillary field. Embolism of the smaller branches of the pulmonary artery takes place with haemorrhage around these arterioles. The larvae readily work their way along with the effused blood into the air vesicles and thence into the bronchi and trachea.

"(2) The larva after hatching in the stomach or duodenum travels up the bile duct and reaches the bile capillaries of the interlobular zone.

It here bores its way through the degenerated liver tissues and reaching the hepatic venule continues its course as in the first case.

"During the residence in the body of the rat or mouse the larvae grow from a length of 0·22 mm. to 1·4 mm. The proportion length of oesophagus / total length diminishes from 1/2·5 to 1/6·1. The ventral line which is the greatest of the longitudinal lines in the embryo is reduced to the same dimensions as the dorsal and lateral lines. The ventral gland (the rudiment of the excretory system) is developed from a cell of the ventral line, enlarges very greatly, acquires the massive nucleus characteristic of *Ascaris* larvae (Stewart, 1906; Baylis, 1916) and finally develops its duct from the cells of the ventral line. The intestine, anal canal and anus become pervious. The rudiment of the female gonads appears."

It appeared from the results of the first experiments that the larvae which had reached the trachea and mouth on the eighth day after infection migrated in the saliva of the rodent on to food substances such as bread. It was shown that they could live for 24 hours on damp bread. Experiments also tended to prove that the larvae from the lungs of rodents could infect the pig and that in nature infection of the pig and man probably took place by means of food contaminated with the saliva of rats or mice. However, the author performed a series of further feeding experiments with *Ascaris suilla* eggs and thereby traced the life-history in the rodents from the eighth to the 15th day after infection and thus found that the preceeding statements required some modification.

"Larvae are found in the mouths of infected mice on the 8th day, on which day they are also, as previously stated, abundant in the lungs and trachea. They persist in the lungs up to the 15th day. On the 9th day they begin to travel down the alimentary canal and may be found in small numbers in the stomach, small intestine and caecum. On the 10th day this stage is fully established, the larvae travel with some rapidity through the stomach and small intestine and accumulate in the caecum and upper colon where as many as 60–70 may occur. On this day they also commence to pass out in the faeces. The passage from the lungs to the caecum continues up to the 15th day and larvae occur in the faeces on the 16th day.

"Between the 9th and the 15th days the larvae increase in length. They measure from 1·3–2 mm. on the 10th day and 1·75–2·37 mm. on the 15th."

The author then gives details with regard to the anatomy of the larval human and porcine ascarids from the large intestine and faeces of the mouse between the 10th and 15th day after infection.

In a further series of pig-feeding experiments it was shown that ripe eggs of *Ascaris suilla* could hatch in the intestine of the pig; the larvae issuing from these eggs entered the body of the pig and pursued the same course through the body as in the rat and mouse. They were found in the lung of the pig from the sixth to the eighth day; dead larvae were found in the faeces of the pig on the 11th day after infection. The migration of the larvae caused severe dyspnoea and cyanosis in two of the pigs four days after feeding, and death on the eighth day; enormous numbers of larvae were found in the lungs and trachea. In the third pig killed six days after infection the pleura was found studded with small patches of ecchymoses; ascarid larvae were present in these patches and throughout the lungs in large numbers; none were found in the liver.

The production of pneumonic symptoms by feeding with eggs of ascarids was observed as long ago as 1860 in a remarkable experiment performed by Mosler on the human subject.

"Mosler, after a preliminary and negative experiment on himself, administered ripe eggs of *A. lumbricoides* to a number of children, at first in small numbers, but later several dozen to each child. No worms were at any time evacuated after anthelmintic treatment but in one (or two) of the children, fever with dyspnoea occurred a few days after the administration of the eggs. Leuckart adds that it is of course doubtful whether this fever was due to the experiment. There can now however be little doubt that the fever and dyspnoea were due to pulmonary ascariasis, the dose in one or two cases having probably exceeded several dozen."

The question still remains open as to whether the ascarids of man and the pig undergo their complete normal development in man and the pig. Thus, (a) the development in the rat and mouse is merely an accidental development in an abnormal host, or (b) the rat and mouse are intermediate hosts and the larvae passed in the faeces of these rodents can either at once or after further development infect the definitive host. The former hypothesis appears simpler and should be easily susceptible of proof or disproof by a moderately numerous series of experiments. The infectivity of the material administered could be established by the subsequent appearance of pneumonic symptoms between the seventh and the tenth days after feeding or by testing the material on rodents in which animals a pulmonary infection appears to follow constantly after artificial feeding with live eggs. Six experiments of this kind were performed. In two of these the pigs undoubtedly suffered subsequently from Ascaris pneumonia; in another there was also some evidence of this condition: the culture used on two of the remaining three pigs was proved active on mice, while in the remaining case four different cultures were employed, the eggs in each case containing active embryos. The results obtained by post-mortem examination of the pigs some time afterwards showed that out of six experiments five were negative and only one possibly positive.

"Considering the very large number of larvae which must have reached the intestine, more than a thousand in each case, and the regularity and certainty with which the hepatic-pulmonary infection follows the administration of eggs in both the rat, mouse and pig, the evidence of these six experiments is opposed to the hypothesis of direct development without an intermediate host. Nevertheless, six experiments are not sufficient to decide the matter and it must therefore still be considered unsolved."

Two controlled experiments were performed in order to determine whether pigs could be infected with the larvae from mice. It was difficult to obtain a sufficient number of larvae from the caecum of the mouse for if large doses are given to this animal it dies before the ninth day, while if small doses are given only very small numbers of larvae are subsequently found in the caecum. Positive results were apparently obtained in one experiment, but the author rightly draws no conclusions from the small number of experiments performed.

Experiments were then made in order to determine a method of obtaining numbers of Ascaris larvae from the caeca of mice.

With regard to the anatomy of the larvae of *Ascaris suilla* from the pig the only difference noted, compared with the larvae from rodents, was that the excretory gland lay slightly further back, the nucleus being on a level with the posterior end of the oesophagus.

Dealing with the economic importance of ascariasis in pigs Stewart quotes the American author, LYNCH, who states that "in the large packing houses of Chicago, Kansas City and Omaha the parasites are

found in large numbers in nearly half of the animals slaughtered." The Colonial Veterinary Surgeon, Hong Kong (GIBSON A.) estimates that at least 50 per cent. of the animals slaughtered at the abattoir of that colony are infected. The author himself examined 83 pigs from the Hong Kong Dairy Farm and found 24 per cent. infected. The animals on this farm were kept in exceptionally good sanitary surroundings and it might be expected that the infection would be low. With regard to the condition of these animals 44 were classed as doing well and 39 as doing badly. In the former group 11·3 per cent. were infected, in the latter group 33·3 per cent. The author, moreover, obtained information that pneumonia was a common disease of young pigs in the Colony and that a pig which had suffered from pneumonia was considered unthrifty and slaughtered forthwith to save waste of food. It is suggested that a certain number of these cases might be due to ascariasis.

Details are added regarding the development of the eggs of *Ascaris lumbricoides* in various media.

The early life history of Ascaris mystax *Zeder* (A. marginata *Rud.*).—

"The development of the eggs of the *Ascaris* of the cat and dog has been studied by Nelson, Verloren, Davaine, Baillet and Grassi (Railliet, *Traité de Zoologie Méd. et Agric.*) and by Leuckart (*Menschl. Parasiten*, II. pt. 2, p. 275). . . .

"Segmentation and the formation of an active embryo have been found to take place in water and damp earth. Davaine (quoted by Leuckart) states that development takes place also in a dry condition. Leuckart gives the period necessary for the formation of an active embryo in summer as four to ten weeks and in winter several months. The fully formed embryo differs from that of *A. lumbricoides* in being larger, 0·36–0·42 mm. in length as compared with 0·3–0·38 mm. in the latter, and in bearing a more distinct boring tooth on the ventral aspect of the mouth. There are no signs of the oesophageal bulb of the adult with the exception of a slight swelling of the posterior end of the oesophagus. He gives a figure of the embryo.

"This investigator did not succeed by any means in bringing about the hatching of the eggs, nor did he produce any further development by feeding experiments. At one time he considered that he had empirically caused direct infection since he found young worms 3–4 mm. in length in the intestines of dogs which had been kept a long time in a kennel on the floor of which he found embryo-containing eggs. Repeated attempts at artificial infection in more than two dozen cats and dogs gave however negative results. He then attempted to find an intermediate host. He administered eggs of the worms to rabbits and mice and examined these animals after several weeks hoping to find encapsuled nematodes. No such nematodes were found. He states that the eggs passed unaltered through the alimentary canal of the mice.

"In a later experiment he placed a number of young cats in a particular dwelling in which a number of animals had recently been kept. The latter had been found to harbour numerous young Ascarids. The cats were fed on bread only. After six to eight days the cats were killed. They proved to be infected with Ascarids 4–8 mm. long. In the stomach of one of them, a kitten eight weeks old, 40 to 60 nematode larvae were found which measured 0·4–0·6 mm. The stomach also contained fragments of straw and potato. No explanation could be given of the mode of entry of these larvae. No animal remains were found in the stomach or intestine to point to an intermediate host.

"Grassi (I quote from Railliet's text-book) reared young puppies in a kennel soiled with egg-containing excrement. Their faeces contained *Ascaris* eggs on the 28th day and numerous Ascarids were found on section. A control experiment in sanitary surroundings proved negative. Grassi concluded that infection was direct."

In order to study the segmentation of the egg and development of the embryo the author made cultures of the eggs of *A. mystax* in a damp atmosphere at a temperature between 25° and 30° C. "Under these conditions development proceeded as follows:—1st day, unsegmented to three cell stage; 2nd day, advanced segmentation; 4th and 5th days, curved vermicules; . . . . 7th day, plump vermiform embryos; 8th day, active embryos."

Intermediate host of *A. mystax*.—Ripe eggs were administered to mice in their food. "Active Ascaris larvae were found in the liver between the 1st and 3rd days after infection." The material at the author's disposal was unfortunately not large enough to work out further details.

The specimens from the liver killed by heat in salt solution gave the following measurements. Larva 20 hours after infection, total length, 0·38 mm.; oesophagus length, 0·122 mm.; relation of length of oesophagus to total length, 1 to 3·11; maximum breadth, 0·017 mm. The length and breadth were practically the same as in the embryo, the oesophagus had shortened markedly. Larva on the third day after infection, total length 0·42 mm.; oesophagus, length, 0·130 mm.; length of oesophagus to total length, 1 to 3·23.

HALL (Maurice C.) & FOSTER (Winthrop D.). **Efficacy of Some Anthelmintics.**—*Jl. Agric. Res.* 1918. Feb. 18. Vol. 12. No. 7. pp. 397–447. With 5 tables & 1 text-fig.

Information with regard to the value of anthelmintic treatments in human and veterinary medicine has hitherto been based largely on clinical observations. A more satisfactory method of investigating the efficacy of the drugs employed would be to administer them to infected animals, collect all faeces passed for a number of days, recover from them all worms present, and then kill the animals and collect all the worms remaining in the digestive tract. With the data thus obtained it would be possible to express the efficacy of a drug in the form of a mathematical ratio. The experiments described by the authors in this paper were based on this principle. In some cases it is very evident that the number performed are somewhat inadequate for the purpose of formulating such ratios and, as the authors admit, these cannot be considered an accurate index of the efficacy of the drug except when based on extensive data, "since many factors, not entirely within control, such as the individual reaction of the animal, the amount of material in the alimentary tract, and the potency of the drug, all enter into the problem." However, their work is of value inasmuch as no such method as the above appears to have been employed by previous investigators, with the exception of HUTCHEON (1891), who made numerous tests of anthelmintic treatments for stomach worms in sheep and goats in South Africa, and STILES (1901–1902) who performed similar work in the United States of America. The following was the method adopted by Hall and Foster:—

"The animals were given an appropriate dose of the anthelmintic to be tested, the method of dosage varying with the purpose of the experiment and the substance to be tested, preliminary purgation being undertaken or omitted as desired. Treatment was usually administered in the morning and all feces were collected every morning thereafter until the animal was killed. The feces were washed through a set of graded

screens and the screens examined for worms. The animal was usually killed the morning of the fourth day after the administration of the last dose of the anthelmintic, and all parasites remaining were collected and counted. The percentage of efficacy was then estimated from the number of worms found on post-mortem examination and that number plus the number passed after treatment. When preliminary purgation was resorted to, the feces were collected on the following day, the day of administering the anthelmintic, to ascertain what worms if any were removed by simple purgation."

The experimental data concerning these investigations, which were performed on dogs, sheep, pigs, cats, and poultry, are arranged in three groups representing, (1) simple purgatives including calomel, castor oil, and Epsom salts, (2) a group including anthelmintics of a mineral nature and coal tar products, including tartar emetic, chloroform, ether, iodoform, copper sulphate, gasolene, petroleum benzine, and the phenols, and (3) a group covering the vegetable anthelmintics including Oleoresin aspidii (or extract of male fern), pelletierine tannate, areca nut, santonin, thymol, turpentine, *Ficus laurifolia*, spigelia, tobacco, and oil of chenopodium.

According to this plan the writers endeavoured to test as many drugs as possible having a known or alleged anthelmintic value, abandoning those that give no results and making further experiments with the more promising. [It is very noticeable that a mineral compound of such recognised anthelmintic value as arsenic is omitted from their list.—Ed.]

The following conclusions are drawn up:—

"Making due allowance for the paucity of data in regard to certain drugs, the writers consider that the following may be reasonably advanced as the result of their investigations.

"Simple purgatives, calomel and castor oil, may have some slight value as anthelmintics, but it is hardly sufficient to justify their use for this purpose. Ascarids in dogs are sometimes removed by castor oil given as a preliminary purge, and this fact may prove of benefit in veterinary practice as a diagnostic measure when the more accurate method of microscopic faecal examination can not be carried out. However, castor oil failed to remove ascarids more frequently than it succeeded, and in no case were all the ascarids removed from any one animal. As many of the experiments on dogs were preceded by a dose of castor oil, the writers have fairly extensive data on this subject.

"The most reliable vermifuge for ascarids, whether in dogs or swine, is oil of chenopodium. This drug, which was tested out on 34 dogs in six experiments, showed an efficacy for the entire series of 97 per cent. It rarely fails to remove all the ascarids present in a dog if given at the rate of 0·2 mil [1 mil=nearly 1 gramme] per kilo, preceded by a dose of castor oil and the animal starved for 24 hours before treatment.

"The chenopodium treatment is also very efficacious for ascarids in swine, and when properly administered may be expected to remove most, if not all, of the worms present. It would seem, however, that neither chenopodium nor any other drug tested will give satisfactory results if mixed with the daily ration and the animals allowed to dose themselves; it is best given to each pig individually in suitable dosage, preceded by a fast. While this method necessarily involves considerable labor when treating animals as unruly as swine, the labor can be reduced by sorting the hogs roughly into classes according to size and confining them in inclosures which will permit them to be caught with a minimum amount of struggling. The treatment has proved practical on a large scale and the results, as far as they could be determined, were entirely satisfactory.

"Oil of chenopodium appeared to be effective for stomach worms in sheep, although the data on this subject are not sufficient to warrant its recommendation. It is also of some efficacy for hookworms in sheep and in dogs, though in the latter case chloroform was found more reliable.

"Other remedies which seem to have more or less merit as anthelmintics against ascarids are the latex of *Ficus laurifolia*, santonin in repeated doses, and thymol. Although thymol in repeated doses is fairly efficacious against hookworms, it was inferior to chloroform for this purpose, causing more distress. An excellent preparation for mixed infestation in dogs consists of equal parts of oil of chenopodium and chloroform, given at

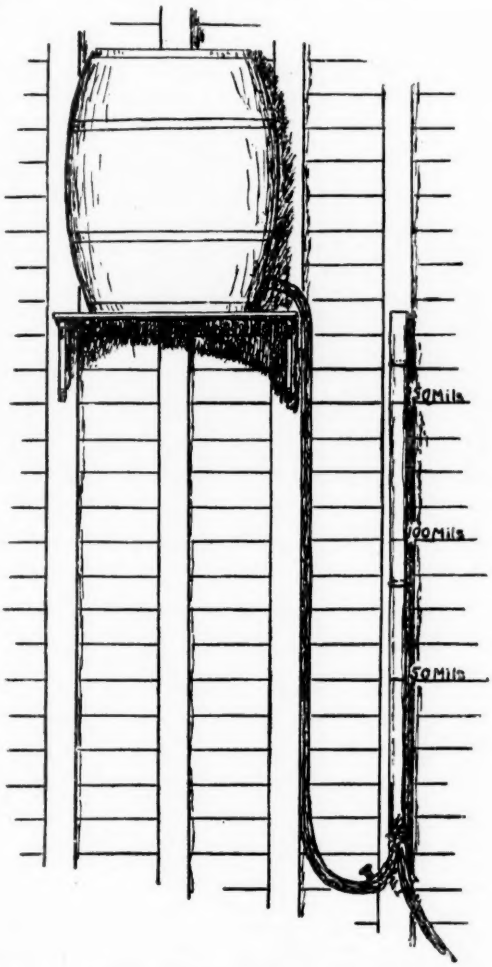


Fig. 1. Apparatus, with control, for administering copper-sulphate to sheep. [Reproduced by permission from the *Jl. Agric. Res.*]

the rate of 0·2 mil per kilo, combined with 30 mils of castor oil. This preparation may be expected to remove all the ascarids present, a large proportion of hookworms, and possibly a certain percentage of whipworms. This latter parasite seems to be very difficult to eliminate, and nothing tried by the writers proved very efficacious, almost any anthelmintic occasionally proving successful. This experience may perhaps be explained

by an intermittent peristalsis of the cecum, which occasionally allows the anthelmintic to enter, but which usually excludes it. Although chloroform was fairly successful in removing stomach worms from sheep, both animals upon which it was tried subsequently died from its effects, and it would seem to be too dangerous for use on sheep.

"In the case of stomach worms in sheep, copper sulphate was found to be the most satisfactory remedy, the experiments confirming the findings of Hutcheon. A simple apparatus (see fig.) devised by the senior writer reduces the labour involved in drenching a flock of sheep and insures accurate dosage. Petroleum benzin also proved satisfactory and was more efficacious for hookworms than copper sulphate. However, it is much more expensive than copper-sulphate solution, must be given three times, and in a vehicle like milk, which adds greatly to the expense. The fact that petroleum benzin (refined gasoline) proved efficacious, while commercial gasoline was considerably less so, is perhaps related to the differences in specific gravity and consequent volatility of the refined product compared with the commercial product.

"Among anthelmintics intended for use against tapeworms, male-fern proved efficacious when tested on dogs. In the case of cats it removed all tapeworms from 75 per cent. of the animals tested, though it proved fatal to two out of six animals which were somewhat enfeebled from disease. Apparently it is more toxic to cats than dogs and should be prescribed with caution and only given to healthy subjects. So far as can be judged from a single experiment with dogs, there seems to be no danger in combining male-fern with castor oil, as is done in the so-called Hermann's mixture. In fact, the writers are inclined to agree with Seifert (1908) that the administration of castor oil after male-fern will avoid the toxic effects of the latter by causing its rapid and thorough elimination, and that for this purpose no other purgative is quite so effective. This subject, however, should receive more study before conclusions are drawn.

"Pelletierine tannate was a failure in the one experiment in which it was tested on cats, but was efficacious on dogs. No remedy was efficacious against tapeworms in poultry. Of the four drugs tested, chenopodium gave the best results for this purpose, but its efficacy for tapeworms is very slight.

"Turpentine proved the most efficacious of the remedies tested on poultry for the removal of *Ascaridia perspicillum*, while chenopodium was nearly as good. When tested on dogs and pigs, turpentine was not very efficacious; and, as it caused grave symptoms of nephritis in pigs and caused the death of some of the experiment dogs, its use upon these animals is inadvisable.

"The treatment with chopped tobacco stems recommended by Herms and Beach for ascarids in poultry proved fairly efficacious for *Heterakis papillosa* and would presumably be at least as efficacious for *Ascaridia perspicillum*, since this latter worm is more easily reached by anthelmintics than is *H. papillosa*.

"There are a large number of drugs showing a greater or less degree of efficacy for the various intestinal parasites of domestic animals. Usually their action is selective—that is, they show a pronounced efficacy for certain species of intestinal worms, while they are decidedly less efficacious or entirely inefficacious against other intestinal parasites. If we consider the ideal anthelmintic one which will remove all worms of a given class or species, and do this every time in a single dose, we find that very few drugs approach this ideal.

"Among the drugs which have given the best results under experimental conditions for the purposes intended and concerning which the writers have sufficient data to warrant positive conclusions may be mentioned the following:

"(1) Copper sulphate in drench for stomach worms in sheep.
"(2) Oil of chenopodium for ascarids in pigs and dogs.
"(3) Oleoresin of male-fern for tapeworms in dogs.
"(4) Turpentine for *Ascaridia perspicillum* in fowls.
"(5) Chopped tobacco stems for *Heterakis papillosa* in fowls."

GILCHRIST (J. D. F.). **The Life-History of *Distoma luteum* n. sp. With Notes on Some Cercariae and Rediae found in S. Africa.** —*Parasitology.* 1918. Apr. Vol. 10. No. 3. pp. 311–319.

Although fluke disease in sheep is very common in certain parts of South Africa the intermediate host of the parasite has not been recognised. The fresh water snail (*Limnaea truncatula*) which is the intermediate host in Europe has not been recorded with certainty in South Africa. The commonest fresh water snail there is *Physa* (*Isidora*) *tropica* and this mollusc harbours in great abundance stages of fluke very closely resembling those of the liver fluke, the important difference, however, being that even when placed in the most favourable conditions the free-swimming form (cercaria) was never observed to encyst.

The author's investigations proved that the forms found in this snail were in reality stages in the life cycle of a small fluke commonly found in the alimentary tract of the frog in South Africa. The adult form was very similar in appearance to *Distoma echinatum*, and on account of its colour it is named by the author *D. luteum*.

The problem as to the life cycle of the South African liver fluke thus still remains unsolved.

EPIZOOTIC LYMPHANGITIS.

BOQUET (A.) & NÈGRE (L.). **Culture du parasite de la lymphangite épizootique et reproduction expérimentale de la maladie chez le cheval.** [The Cultivation of the Causal Organism of Epizootic Lymphangitis and Reproduction of the Disease Experimentally in the Horse.]—*C. R. Acad. Sci.* 1918. Feb. 18. Vol. 166. No. 7. pp. 308–311.

In spite of the researches of TOKISHIGE, MARCONE, and SAN FELICE, who have published the results of attempts at cultivating the cryptococcus held to be the cause of epizootic lymphangitis some doubt still existed on the nature of the parasite, for during recent years certain authors have described it as a protozoon. One of the authors in collaboration with BRIDRÉ (1910) showed that the cryptococcus behaved in the same manner as one of the Blastomycetes in the deviation of the complement test. In this article the mycotic nature of RIVOLTA'S cryptococcus is demonstrated by its development in mycelial form in sub-cultures and by the reproduction of the disease experimentally by inoculation of these cultures into a horse.

The cryptococcus was cultivated on horse-dung agar covered with a film composed of macerated lymphatic gland pulp from a horse [see this *Bulletin*, Vol. 5, No. 2, p. 116]. After sub-cultivating two or three generations the addition of the latter material became no longer necessary. The authors succeeded in transplanting these cultures on to Sabouraud's agar, potato, and carrot, and in this way obtained up to the 12th sub-culture on all these media.

Positive results were obtained in the deviation of the complement test with the serum of infected horses when the above cultures were used as antigen.

In two cases the disease was set up in the horse by subcutaneous inoculation of cultures in the regions of the poll and the shoulder. The first experiment was performed by inoculating colonies from a first sub-culture, still containing cryptococci, and the second with colonies from an 8th sub-culture obtained from a strain isolated 11 months previously.

At the seat of inoculation there appeared 24 hours after injection a large oedematous swelling which disappeared in 5 or 6 days. A small nodule which remained stationary was then left and in three or four weeks this firm nodule of fibrous consistency commenced to become enlarged. It then contained cryptococci apparently smaller in size than ordinary crytococci and without a double envelope.

The nodule become softened in some instances and discharged a pus containing typical cryptococci which were all enclosed within leucocytes. The lesion then became sometimes cicatrised and arrested in its development.

In other cases after or without partial abscess formation the fibrous nodule increased in size and a corded lymphatic with nodules distributed along its course then arose from it. This generalisation did not appear until the sixth or seventh week after inoculation. The corded lymphatic developed as in the case of the natural disease.

Inoculation of material intra-cutaneously or on to the scarified shaved skin gave rise only to localised abscesses containing cryptococci.

The first horse that had been inoculated and had recovered from the infection remained refractory to subsequent inoculations whilst a control horse inoculated at the same time with the cultures contracted the disease. Vaccination and bacteriotherapy by means of heated cultures are in course of investigation.

Lindner (P.) & Knuth (P.). **Untersuchungen über einen im Eiter eines an der epizootischen Lymphangitis erkrankten Maultieres gefundenen Pilz (*Monilia capsulata*).** [Researches with regard to a Mould (*Monilia capsulata*) found in the Pus of a Mule Affected with Epizootic Lymphangitis.] — *Ztschr. f. Infektionskr. d. Haustiere.* 1916. Vol. 17. No. 5. pp. 290–308. With 2 text-figs. & 4 plates comprising 24 figs.

In a number of smears of epizootic lymphangitis pus received in 1911 from German East Africa and kept in the laboratory for from six to eight months Knuth succeeded in obtaining colonies of mycelial growth on planting the material on prune agar. A further detailed study of the growth obtained from Knuth's cultures and from the still living organisms in the smears was then carried out by Lindner, who figured the sprouting of mycelial threads with clusters of moniliform encapsulated elements attached to them on incubation at temperatures below body temperature. Knuth, however, failed to set up appearances resembling those of naturally occurring epizootic lymphangitis after inoculation of large quantities of the growth into susceptible horses.

BACTERIAL DISEASES.

VINCENT (H.). **Sur la prophylaxie de la Fièvre de Malte par l'immunisation active des animaux vecteurs du germe.** [Prophylaxis of Malta Fever by Active Immunisation of Animals acting as Carriers of the Causal Organism.]—*C. R. Acad. Sci.* 1918. Feb. 25. Vol. 166. No. 8. pp. 359–362.

"Although it was originally considered as a disease confined to Malta and Gibraltar, Malta fever is in reality observed in a large number of countries, especially those bordering on the Mediterranean Sea. It is by no means rare in France where it has given rise to veritable epidemics (Cantaloube, Friley).

"It would certainly be erroneous to consider the goat as the principal reservoir of the Malta fever virus (Zammit, Horrocks, Kennedy, Shaw, etc.), since other animals are capable of becoming infected in the same way and are therefore contagious for man. Nevertheless it appears from the numerous works published on the subject that the goat holds chief place as etiological factor of the disease.

"On account of the economic importance of goat breeding it appeared that the publication of the result of investigations on the prevention of Malta fever by active immunisation of the animals susceptible to this disease would prove of value. Anthrax, which formerly caused great ravages among stock and became transmitted by the latter to man has become rare in both instances since the application of anti-anthrax vaccination to herds of cattle and sheep according to the rules prescribed by Pasteur.

"One is led to believe that active immunisation of the goat against *Micrococcus melitensis* is capable of realisation, for this animal in most cases only presents very slight morbid symptoms although it may harbour the causal organism for a long time in its urine and milk. Moreover, the goat may recover spontaneously after a varying interval. After recovery it has acquired immunity (Bruce). It was thus attempted to increase this natural resistance by means of vaccination with several strains of *M. melitensis* (Vincent H. and Collignon, 1910).

"Immunisation of animals by means of living virus, even if it has been attenuated, cannot be undertaken inasmuch as one would produce cases of infection and would thus facilitate the dissemination of *M. melitensis* through the agency of these carriers of the organism. It thus becomes necessary to vaccinate them with a dead virus.

"Agar cultures three or four days old were diluted in normal saline solution, then sterilised by shaking with ether and left in contact with this liquid for two hours. A thick oily layer is formed on the surface which is thrown away. Only the underlying emulsion is utilised.

"The vaccine is polyvalent. It is at present prepared with 10 strains of *M. melitensis* and one strain of *M. para-melitensis* forwarded by Edmond Sergent (from Algeria) and Moragas (from Barcelona). . . . The vaccine contains about two thousand millions of the micrococci per cubic centimetre. Two doses of 2 c.c. each are injected at 5 or 8 days interval.

"The following experiments were made in order to obtain proof of the degree of immunity conferred by these injections. A first lot of two adult goats was vaccinated, in 1910, after ascertaining that the blood possessed no agglutinating properties. One received 3 c.c. and the other 4 c.c. of the vaccine subcutaneously three times and at 8 days interval. A month afterwards a 4 c.c. dose of living virulent culture was injected into the jugular vein.

"These test injections of large doses of the living organism only brought about a slight increase in temperature. The fever disappeared on the following day. The second goat had transient diarrhoea. Both animals remained in an absolutely normal state of health and fattened considerably. Their blood was sown out on culture media on two occasions, viz., 8 days and 1 month after the test inoculation, but no growth was obtained. The second goat became pregnant four months afterwards and gave birth to two perfectly healthy kids at full term.

"Two young he-goats 6 and 8 months old, respectively, were immunised by single *intravenous* injection of 2 c.c. of vaccine; subsequently they showed only a slight febrile reaction. In order to test their immunity they were injected four weeks afterwards into the jugular vein with 4 c.c. of living virulent culture. This test injection gave rise to more distinct reactions than in the case of the she-goats vaccinated by subcutaneous inoculation. The two goats had a temperature of 40° C. with slight diarrhoea and inappetence. Nevertheless these symptoms did not persist and their growth afterwards took place normally. Blood and urine from them sown out on media three and six weeks afterwards did not give rise to a growth of *M. melitensis*.

"Another adult she-goat and two kids, 2 and 3 weeks old, respectively, were vaccinated by means of double injections. One month afterwards the whole of a three-day-old growth from a slope agar tube was inoculated intravenously into the she-goat and the same quantity of living virus was inoculated intraperitoneally into the two kids. Two months afterwards the two kids were fed for a week with food material mixed with *M. melitensis*. All three animals remained immune. The she-goat was killed after a month's interval and the two kids were killed, one after 3½ months and the other after 9 months, the animals having been kept off food for a day before slaughter. Heart blood, spleen pulp, liver pulp, bile, kidney tissue, urine, and bone marrow (femur) sown out on culture media remained absolutely sterile.

"It is known that in the case of goats experimentally inoculated by subcutaneous injection *M. melitensis* may be found in the internal organs for one year or even 16 months afterwards (Zammit).

"The preceding experiments thus show that the vaccinations set up in the goats a powerful immunity which protected them against a very large dose of the virus introduced subcutaneously, intravenously, intraperitoneally, or by the digestive tract.

"By this method . . . more than 200 young or adult goats were vaccinated; also the goats of the Natural History Museum, Paris, were treated in the same way in 1910 and 1911. After a preliminary examination of the blood and after demonstrating that it had no agglutinating power towards *M. melitensis* vaccination was performed (1) on adult he- or she-goats; (2) on kids from 2 to 3 months old; (3) on goats from the first to the third month of pregnancy; (4) on milch goats. The vaccination did not produce any noteworthy symptom. The injections led, a few hours afterwards, to a rise in temperature of 0.5 to 1.0° C; the following day the temperature was normal, the goats maintained their appetite; pregnant animals did not show any morbid symptom and subsequently parturition in these animals was absolutely normal.

"By the application of these measures for immunising goats and other animals capable of transmitting Malta fever through their milk or milk derivatives or even by direct contagion one is thus enabled to protect both these animals and indirectly man himself against that grave disease."

LISTON (W. Glen) & SOPARKAR (M. B.). **The Susceptibility of Indian Milch Cattle to Tuberculosis.**—*Indian Jl. Med. Res.* 1917. July. Vol. 5. No. 1. pp. 19–71. With 2 tables, 22 charts, 3 plates & 18 coloured full-page charts and diagrams.

According to the opinion of a large number of observers bovine tuberculosis is of rare occurrence in India although in certain localities it has, however, been lately shown to affect quite a considerable proportion of the cattle population as, for example, in the Punjab [see following extract]. The comparative rarity of the disease in India has been attributed by many to the proportionally greater open-air life of Indian cattle than of European and American cattle. This explanation, however, does not apply to cattle housed in a large city like Bombay, where, according to recent reports, there are about 43,000 cattle housed in byres or cattle sheds. The freedom

from tuberculosis of these cattle might be attributed to a relatively greater resistance to the disease than is the case with European or American cattle. The experiment described in this paper was performed with the object of testing this assumption and hence the plan adopted was to inject native cattle subcutaneously with large and small doses of bovine tubercle bacilli and compare the effects produced with those obtained in the case of English cattle similarly treated. It is unfortunate that the authors did not find it possible to utilise a number of imported European cattle for control purposes in their experiment, but inasmuch as the work could not be carried out under such rigorous conditions a strain of bovine virus which was used in the experiments of the English Royal Commission on Tuberculosis was obtained from Dr. EASTWOOD, one of the workers under that Commission. Cultures of this strain were found to be highly virulent for rabbits.

Fifty milligrammes of culture of the bovine organism is known to produce almost invariably in English cattle a generalised progressive tuberculosis, while 10 milligrammes often brings about a fatal result. Twelve buffalo and 12 cow calves from four to eight months old were thus inoculated subcutaneously in front of the shoulder with virulent culture; in each of these two lots of animals six received 50 mgms. and the other six 10 mgms. A buffalo calf and a cow calf purchased at the same time were not inoculated but left to serve as controls. The buffalo calves were in a weakly condition at the time of inoculation and the control animal died on the day after the experiment began.

In their protocols the authors record the changes occurring at the seat of inoculation, the condition, body weight, and daily temperatures of the animals throughout the course of the experiment. The results of the post-mortem examinations after natural death or slaughter are also given and elaborate figures are drawn to illustrate the distribution of the lesions in the Indian calves as compared with those described in the case of English calves experimented on under similar conditions, as detailed in the Reports of the English Royal Commission on Tuberculosis.

The authors summarise their results as follows:—

"While the experiments of the Royal Commission on Tuberculosis show that, with rare exceptions (1 out of 35), all English calves die of acute tuberculosis when inoculated with 50 mgms. of a culture of bovine tubercle bacillus, our experiments prove that at least 50 per cent. (6 out of 12) of Indian calves, whether they be buffalo or cow calves, live for many days after a similar dose of culture of the bovine bacillus and when killed show only retrogressive or healing tubercular lesions.

"The experiment confirms the general experience that Indian cattle are less commonly affected by tuberculosis than English cattle are, and supports the view that the comparative infrequency of the disease among cattle in India is due to a natural resistance rather than to any method of housing or keeping cattle in India as compared with England.

"Nevertheless certain Indian calves seem to die as quickly from generalized tuberculosis, after the subcutaneous injection of even 10 mgms. of culture, as English calves do, so that there is a considerably greater individual variation in susceptibility to infection by the tubercle bacillus among Indian as compared with English calves. Whether this variation be associated with differences in the breeds of the calves used by us has not yet been determined. It, however, follows that the comparative rarity of tuberculosis in Indian cattle must in part at least be attributed to diminished opportunities for acquiring infection.

"The possible existence of tuberculosis among certain imported breeds of cattle and their liability to contract tubercular infection is therefore a source of danger to indigenous herds. One out of three definite cases of tubercular disease in cattle in India which came under our observation was found in an English bull which had been kept at the Allahabad Military Dairy Farm. Attention should be paid to this point when attempting to develop a more useful milk-yielding stock than is at present available among the indigenous breeds.

"It remains only to draw attention to another important point. On account of the constancy with which a dose of 50 mgms. of a culture of tubercle bacillus of bovine type causes acute generalised tuberculosis when injected subcutaneously into calves, this method has been recommended by all great workers in Europe and America, as a means of distinguishing between tubercle bacilli of typus bovinus and typus humanus. Our experiments prove that, when using Indian breeds of cattle at least, this test cannot be relied on, for in 50 per cent. of the calves the effects produced by such an inoculation do not materially differ from the effects produced by the injection of a similar dose of tubercle bacillus of typus humanus in English cattle.

"Incidentally our experiment sheds some light on the practical absence of tuberculous lesions caused by the bovine type of bacillus in children and adults in India. This is a subject which will be discussed in a subsequent paper."

TAYLOR (G.). **Note on the Prevalence of Bovine Tuberculosis in the Punjab.**—*Indian Jl. Med. Res.* 1918. Jan. Vol. 5. No. 3. pp. 497–509. With 1 table.

Hitherto tuberculosis in cattle has not attracted much attention in India, the general idea being that the native cattle are comparatively free from the disease. This idea, however, appears to be erroneous according to the data furnished by Taylor in this paper, which is based upon observations recorded subsequent to the institution of a proper system of meat inspection at Ferozepore Cantonment slaughter-house, Southern Punjab.

The enquiry was carried out from August 1915 to March 1916, during which period 3,276 animals were admitted for slaughter. These animals had arrived almost entirely from the Central and South-Eastern districts of the Punjab, and were all of the indigenous breed. The method of meat inspection entailed the examination of all animals while still alive, and thus 575 of the above animals, or 17·8 per cent., were rejected as not likely to be fit for human consumption on account of innutrition, disease, or old age. It is probable that a good many of these cast animals were suffering from chronic tuberculosis. Of the remaining selected animals 95, or 3·5 per cent., presented after slaughter what appeared to be macroscopic tuberculous lesions. In 60 of these cases tubercle bacilli were demonstrable in the lesions on microscopic examination. The distribution of the lesions in each of the affected animals is depicted in tabular form. The animals found to be tuberculous were all females; this would be due to the fact that cows and heifers form by far the largest source of meat supply. The lesions in the selected cattle were nearly all of a localised nature. In all but two cases the disease was confined to the thoracic cavity. The bronchial and mediastinal glands were most commonly affected either alone or associated with invasion of the lungs. In many cases the lesions were so limited in extent that they were only discovered after very careful search. In the two cases mentioned above there

were lesions in the mesenteric glands in addition to those in the thoracic cavity. In only one case was anything like a generalised condition of the disease found, viz., in a cow about 9 years of age. This was the only case in which the udder was affected.

During the year 1916–1917 (1st April–31st March), 4,610 animals were brought for slaughter. Of these 821, or 17·8 per cent., were rejected as unfit for slaughter. Of the remaining animals, which were slaughtered, 125, or 3·3 per cent., were found infected.

The above figures appear to indicate that tuberculosis is by no means uncommon in the Punjab. With regard to the prevalence of the disease in India it is a striking fact that hitherto practically all the cases recorded have been confined to Northern India, the Southern Provinces apparently being free. Further investigation on this subject is required.

DISEASES DUE TO FILTERABLE VIRUSES.

HOWARD (C. W.). **Insect Transmission of Infectious Anaemia of Horses.**—*Jl. Parasit.* 1917. Dec. Vol. 4. No. 2. pp. 70–79.

In natural circumstances equine infectious anaemia appears from the result of experiments to be transmitted most likely by blood-sucking flies and thus investigators have in the course of the last ten years endeavoured to ascertain the species capable of acting as transmitting agents. The JAPANESE COMMISSION (1904), as the result of a series of careful experiments with various insects, emitted the opinion that tabanids were probably the vectors, in view of their great numbers and violent attacks upon horses in affected localities, and also the seasonal occurrence of the disease coincides in Japan with the appearance of the flies. The Commission was, however, unable to handle the flies successfully and so no experiment was tried with them. K. R. & R. SEYDERHELM (1914) incriminated bots. SWINGLE (1914) in Wyoming obtained negative results in his experiments with tabanids but suggested the possibility that the blood voided from the wounds caused by these flies might spread the disease after ingestion; these investigations in Wyoming were continued by SCOTT who concluded that *Stomoxys calcitrans* was the carrier in that district.

The author's work commenced in the spring of 1915 at the Minnesota Experiment Station in co-operation with the United States Bureau of Animal Industry. A careful survey of the biting insects in the areas infected with swamp fever was first made.

In order that a suspected insect might act as transmitting agent of swamp fever in an affected locality it was laid down that it should be found over a very wide area within that district, be a ready feeder on the horse, and able to pass rapidly from one horse to another. The fact also that swamp fever in Minnesota usually begins to appear in July and increases in severity in August, while the incubation period is from 10 to 30 days, "made it appear that the early spring breeding forms were more likely to be the carriers."

Ticks could be eliminated as probable vectors inasmuch as they were not abundant in the affected localities. Species of simuliids

were present and appeared early in the season but not so early as the tabanids and were not present in all parts of the State. Mosquitoes were present everywhere, both inside stables as well as in pastures and certain species appeared early in spring. It has been shown that stable infection is rare and also if mosquitoes were responsible for the transmission of swamp fever it would probably be more widely epizootic. The same applies to the stable fly, *Stomoxys calcitrans*, but it is not abundant in early summer and in that respect does not coincide with the requirements set for possible vectors.

Several species of tabanids appeared in spring and early summer, and in these seasons they appeared as early as the end of May but never later than the beginning of July. The early tabanids were the worst insect pests of horses and cattle in the northern half of the State where much of the land is still virgin timber or swampy in character. These facts concerning the flies seem to fulfil the conditions laid down above and it was decided to begin work with them.

The author then briefly describes experiments in which large numbers of tabanids were brought from the infected areas to the laboratory in an endeavour to induce them to feed on infected and susceptible horses kept separately in wired cages. It was only possible to keep a very few specimens alive for this purpose. A horse known to have been infected for four years was kept in a cage adjacent to one containing a susceptible horse and separated by a double partition of half-inch mesh wire netting. One end of the apartment was cut off from the rest by a partition of insect proof netting for the purpose of containing a control horse. Tabanids were allowed to feed alternately on the infected and susceptible horse for 18 days and during the following 80 days no rise in temperature was noted in the latter animal. It was then inoculated with virulent material and shown to have been highly susceptible.

In the course of the following year an experiment was carried out in somewhat the same manner with *Stomoxys calcitrans*. The feeding of the flies lasted 42 days and 44 days later, blood was taken from the susceptible horse, when it had to be destroyed on account of an accident, and inoculated into another susceptible horse. The latter animal commenced to react 23 days later and death occurred 89 days after the injection; filtered blood from this horse reproduced the disease in another susceptible horse.

"From this experiment it seems probable that swamp fever of horses *can* be carried from one horse to another by the biting stable fly, *Stomoxys calcitrans*.

"The results of these experiments, together with a study of the investigations of other workers has not, however, fully convinced us that insects are the usual or only carriers of the disease."

CORNWALL (J. W.) & MENON (T. Kesava). **On Experimental Immunization against Rabies by the Method of Phisalix.**—*Indian Jl. Med. Res.* 1917. Apr. Vol. 4. No. 4. pp. 688–690.

In 1915 PHISALIX described how rabbits treated intravenously with a solution of the cutaneous mucoid secretion of salamanders, *Siredon mexicanus* or *Rana temporaria*, followed by, or mixed with, a solution of the venom of *Vipera aspis*, which had been heated to 75° C. to reduce its toxicity, resisted subsequent subdural inoculation with the

fixed virus of rabies. This observation appeared to the authors to be of sufficient importance to justify them in repeating the experiments with the materials at hand in India. The technique indicated by PHISALIX was followed as closely as possible, the cutaneous mucoid secretion of *Rana limnocharis* and *R. tigrina* being substituted for that of *R. temporaria*, and the venom of *Daboia russelli* for that of *Vipera aspis*. A series of experiments in which rabbits were inoculated with the cutaneous secretions of these Indian frogs and a dose, just below the minimum lethal dose, of the heated venom of the fairly common Indian viper and, subsequently, were given a test inoculation with fixed rabies virus gave uniformly unsuccessful results. Further, these results did not encourage the authors to believe that success might follow if other combinations were tried, i.e., the secretion of other frogs or the venom of other vipers.

CORNWALL (J. W.). **A Note on the Occurrence of Negri Bodies.**—*Indian Jl. Med. Res.* 1918. Jan. Vol. 5. No. 3. pp. 478–480.

"It has been held that it would be possible to decide by microscopical examination of the brain of a man, who had died from hydrophobia after undergoing a course of anti-rabic inoculations, whether death had been due to the street-virus originally introduced by the bite or to the fixed-virus used in the treatment; death from street-virus would be denoted by the presence of large Negri bodies, from fixed-virus by the absence of Negri bodies, except perhaps a few minute dots. The point is of mere academic interest in India, for fixed-virus in the living state is not used in the treatment." The author then summarily describes the results obtained from a considerable number of experiments performed on guinea-pigs, dogs, and rabbits at the Pasteur Institute of Southern India. From the observations thus made the author summarises his results as follows:—

"(1) Numerous and large Negri bodies invariably occur after (a) subdural inoculation with street-virus brain matter, (b) subcutaneous inoculation with street-virus salivary gland matter, when the latter has proved virulent;

"(2) scattered and minute Negri bodies may sometimes be found after numerous subdural passages in one and the same species;

"(3) scattered, but fairly large Negri bodies may sometimes be found if the fixed virus of one species be subdurally inoculated into another species;

"(4) after subcutaneous inoculations of street-virus brain matter—(a) large and numerous Negri bodies seldom occur, (b) small and numerous Negri bodies often occur, (c) often no Negri bodies at all can be found;

"(5) after subcutaneous inoculations of fixed-virus brain matter, minute Negri bodies may sometimes be found."

EAST AFRICA. **Rinderpest in East Africa.** [By GRAY (C. E.).] MSS. Reports received in Colonial Office, dated 1917. May 25 & July 26. 25 pp. f'cap. With 1 map.

In these reports an account is given of the measures taken to prevent the extension of rinderpest in a southward direction from German East Africa into the Nyasaland Protectorate and Northern Rhodesia. The area in which operations were undertaken embraced the region lying just north of the boundary, that is between the northern

end of Lake Nyasa and the southern end of Lake Tanganyika and south of the Livingstone range of mountains and Lake Rukwa. Before the arrival of the expedition for the control of the disease under Colonel Gray the Nyasaland and Northern Rhodesian authorities set up a barrier against the rapid spread of the disease southwards by removing all cattle from a belt 10 to 20 miles wide south of the German boundary. A few outbreaks had been located south of the Livingstone range and thus it was resolved to clear the disease from the affected localities by the adoption of simultaneous inoculation methods and also immunise by the same method all cattle running in a belt of country about 35 miles wide lying north of the German boundary.

Inoculation camps were thus established at various places in order to carry out this plan but at first the disease appeared to show a tendency to die out naturally, and the native cattle of the districts affected appeared to possess a high degree of natural immunity. Moreover, the experience gained at the inoculation camps showed that certain complicating factors of a somewhat serious character had to be reckoned with when working on a large scale, which were not anticipated when the establishment of a belt of immune cattle along the southern border of this territory was originally contemplated. The original scheme was thus abandoned and instead of it measures were taken to guard the New Langenburg district against the introduction of disease from the other side of the Livingstone range where rinderpest is always more or less enzootic. The most important complicating factor was the appearance of a large mortality from East Coast fever among the cattle collected at the concentration camps. The mortality from this disease did not begin until the animals had been inoculated with rinderpest blood and serum, and, although the occurrence of ordinary redwater as a complication in outbreaks of rinderpest, where the vitality of the animals has become depressed owing to the inoculation, is well recognised, a similar phenomenon has not yet been proved to take place in the case of East Coast fever. Inoculation experiments were thus carried out in order to elucidate this problem and these "appeared to show that such complications were likely to occur, although the mortality therefrom might be negligible, most of our animals showing microscopic evidence of the revival of East Coast fever infection by the appearance of Koch's bodies in their blood whilst undergoing reaction to rinderpest inoculation. None of these died, however, although several control animals inoculated at the same time with rinderpest virus alone and unprotected with serum succumbed after showing during the course of their illness that East Coast fever organisms had again become active."

These experiments appear to prove that the bad results obtained at one of the concentration camps (Old Utengule) were chiefly due to the movement of cattle susceptible to East Coast Fever into an area where that disease was enzootic, for purposes of inoculation, rather than to a serious breakdown in the immunity of animals reared on East Coast fever veld. The records of the German authorities pointed to a very high mortality from East Coast fever among the cattle of this district.

However, as the result of the inoculation rinderpest appeared to have been brought speedily under control. Investigations were then

carried out to ascertain the prevalence of rinderpest immediately north of the Livingstone range of mountains and towards Lake Rukwa and determine whether the mountains could serve as an efficient barrier against the southward spread of the disease. Only one small outbreak was detected and this was dealt with by serum inoculation. Elsewhere the disease appeared to have died out.

Unfortunately, however, in the meantime rinderpest re-appeared in the New Langenburg district south of the mountains and the history of the outbreak showed that it had originated owing to the unauthorised movement of cattle while undergoing a reaction subsequent to inoculation and it assumed serious dimensions owing to the concealment by the natives of the first cases that occurred. This was dealt with by the use of serum alone but later a number of other outbreaks were detected and work had thus to be resumed by adopting the simultaneous method of inoculation and carefully guarding the area in which operations were undertaken.

Gray then adds a few remarks upon the methods employed where large numbers of cattle had to be inoculated in order to effect economy of time and labour with least fatigue to operators working under a tropical sun. The short crush method adopted by GARDEN (G.) was found to answer this purpose best.

"In the short crush method a crush capable of accommodating two animals only is erected, width at bottom being twelve inches, the uprights inclining outwards at an angle which increases the width to two feet six inches, at a height of three feet above the ground. The crush is provided with two sets of slip rails, the one set at the exit from the crush, the other set five feet six inches further back, there being a stout post sunk in the ground in front of the exit, round which the head rope can be hitched in the event of an animal proving refractory. The animals are roped individually in the kraal connected with the crush by the owner, the rope is passed forward along the crush, the head drawn up to the front slip rails and held there by three or four boys, while the slip rails are put in behind it. The inoculators stand one on either side of the crush, and as the animal is secured, they inoculate it simultaneously, brand it, liberate it, and stand ready for the next. With tractable animals and natives who handle the ropes and bring the animals forward quickly, it has been found possible for four operators working at two crushes, to inoculate over eighteen hundred head in a day with much less effort than would be required to handle a similar number by casting them and walking from one animal to another."

Over 11,000 cattle were inoculated at the two new stations; the reactions in many cases were well-marked and although fatal cases were observed in which East Coast Fever infection had apparently been revived by inoculation the mortality due to inoculation was not more than one half per cent. Two or three small centres were found which were stamped out by the use of serum alone.

Unfortunately again, however, rinderpest made its appearance close to the Nyasaland border owing to the movement of a couple of calves out of an infected area by a native headman. This fresh focus of infection lay in the centre of a district containing about 20,000 head of cattle and situated around a route of considerable military importance. Mention is made at the close of the report that the work of inoculating all cattle in the belt of country involved by this fresh outbreak had just been completed and the author then entertained the hope that there was a fairly good chance of keeping the disease out of Nyasaland, especially as intercourse with that

country had been entirely stopped along the Songwe on account of the presence of bubonic plague at Karongo on the other side of the river.

The work had to be carried out under difficulties owing to the diminished number of personnel due to sickness and military requirements.

Moussu (G.). **La peste bovine en Afrique occidentale française.** [Rinderpest in French West Africa.]—*Rec. Méd. Vét.* 1918. March. 15. Vol. 94. No. 5. pp. 105–114. With 1 map.

In the vast extent of territory comprising French West Africa the bovine population amounts to about 6,000,000 head. With proper organisation a very large quantity of meat would thus be available for importation into France. However, according to Moussu, the French authorities in the past have been extremely slow to realise the possibilities of this Colony. Largely at his own instigation a factory was constructed at Lyndiane in Senegal, and from this centre alone 30,000 head of large cattle were exported to France in 1916. Lack of economic organisation appears to constitute the chief cause of the smallness of output of meat for exportation from the Colony. In addition the French authorities have neglected to provide an adequate veterinary service for combating outbreaks of contagious disease. Only nine veterinarians are available for this purpose for the whole tract of immense territory comprising Senegal, Upper Senegal and Niger, Dahomey, Guinea, Mauritania, and the Ivory Coast.

No serious outbreaks of disease have occurred until recently since the years 1891–1893, when rinderpest caused great ravages among the cattle population with the result that a good many breeding centres have not recovered from its effects to this day. Central Africa constitutes a reservoir for the maintainence of rinderpest whence it is liable to spread to the east or north east into Egypt and Eritrea or towards the west into French Soudan, Dahomey and Senegal. The Sahara Desert forms an efficient barrier against its spread into the French possessions along the Mediterranean coast. Moussu quotes reports dealing with the re-appearance of serious outbreaks in various centres from 1915 to 1918, and with the spread of the disease the mortality rate has gradually increased in certain places from 25 per cent. in 1915 up to 90 per cent. more recently. Moussu pleads for the installation of a series of serum stations together with a veterinary organisation for the control of further outbreaks.

Boynton (William Hutchins). **Experiments on the Treatment of Rinderpest with Various Drugs.**—*Philippine Agric. Rev.* 1917. Third Quarter Vol. 10. No. 3. pp. 272–298. With 1 plate.

The drugs used in these experiments were as follows:—(1) eosin; (2) medicinal methylene blue (Merck); (3) cacodylate of soda; (4) atoxyl; (5) quinine sulphate; (6) camphorated oil; (7) creolin; (8) permanganate of potash; (9) ergot; (10) iodine; (11) potassium iodide; (12) gentian violet; (13) arecolin hydrochloride; (14) nuclein; (15) formalin; (16) chlorazene; (17) castor oil; (18) alcohol; (19) fluid extract of nux vomica; and, (20) fluid extract of gentian.

The work was carried out by Boynton at the Laboratory of the Veterinary Division, Bureau of Agriculture, Philippine Islands, and extended over a period of about six and a half years. Altogether 47 experiments were performed, which are carefully described. From the results obtained the author holds that no curative effect could be observed after the use of any of the above drugs in the doses and methods adopted for administration.

Specific cures for rinderpest had been claimed by many people in the course of treatment of outbreaks in the field but statistics showed that in many localities the recoveries of animals under normal conditions were very high, averaging in many instances about 60 per cent. The so-called cures would also undoubtedly have been administered to selected cases in the scene of an outbreak, and this would account for the high percentage of recoveries claimed. Moreover, when these drugs were given a proper trial they were invariably found lacking in curative powers. The drugs tested in the author's experiments were in nearly all cases injected into animals infected with a highly virulent rinderpest strain maintained at the laboratory in connection with the manufacture of anti-rinderpest serum.

However, " Stanton YOUNGBERG, Chief Veterinarian, Bureau of Agriculture, and the several veterinarians in charge of the immunization stations in the province have been using strychnine, nitroglycerin, and echinacoid, on animals which have a severe reaction while passing through the immunization. (Simultaneous method, receiving an infecting dose of V.B. and a supposedly protecting dose of anti-rinderpest serum on the same day or within one or two days of each other.)

" These workers find that all three of the above-mentioned drugs prolong the life of animals by their stimulating effect and in many instances seem to sustain life long enough for the animal to develop sufficient antibodies to combat the disease and in this way make a recovery. They find that when using strychnine great care has to be taken in not stopping the use of the drug too suddenly as its action is very transient and if not administered at short intervals the animal is apt to suffer collapse and die suddenly.

" Although these drugs are practically useless for animals which contract rinderpest in the usual way and have not previously received a protecting dose of serum, the results would indicate that they might be used on animals that have severe reactions while being immunized."

BOYNTON (William Hutchins). **Preliminary Report on the Virulence of Certain Body Organs in Rinderpest.**—*Philippine Agric. Rev.* 1917. Fourth Quarter. Vol. 10. No. 4. pp. 410–433.

Boynton states that from many observations made in his laboratory during the past seven years it had been noticed that the virus of rinderpest was quickly destroyed in decomposing material, either tissue or blood. On the other hand if virulent blood was drawn under aseptic conditions and placed in sterile containers the virus retained its activity for five or six days. If the blood is kept in a clotted form the virus retains its activity for a few days longer. In a previous work (1913) it was shown that when the large water leech (*Hirudo boyntoni* Wharton) was allowed to feed upon an animal suffering from rinderpest the virus might remain active for a period of 25 days in the body of the leech. In this case the blood was kept free from putrefactive organisms and also in a semi-anaerobic condition.

From a study of the symptoms and lesions in rinderpest the author maintains that the virus affects primarily the involuntary muscles and endothelial lining of the capillary vascular system and the parenchymatous tissue; this is prominently demonstrated in the intestinal tract and in the lymphatic system on histological examination. Further, from the results obtained by intravenous injections of various drugs and disinfectants it is held that the seat of multiplication of the virus is not in the blood stream but inside the tissue cells where the disinfectants cannot penetrate, the virus in the blood stream being merely a surplus which is thrown off by these tissue cells.

In this paper the author details the results of experiments performed with the object of determining the virulence for certain organs after extraction with weak phenol solutions in order to keep down the activity of putrefactive organisms to a minimum while the drug had little or no effect upon the virus of rinderpest. The technique adopted was as follows:—

"The tissues were taken from the animal as soon after death as possible. The amount of tissue desired was weighed, and ground in a meat grinder which had been previously sterilised in the autoclave to keep external contamination down to the minimum. The material thus prepared was placed in a sterilised flask and twice as much phenol solution (the strength of the solution is mentioned in the case of each experiment) was added. Both crude phenol and the pure crystal form were used in these experiments with similar results, i.e., 100 grammes of liver was ground and placed in a sterile flask and 200 cubic centimeters of a 0·5 per cent. phenol solution added to it. This material was thoroughly agitated two or three times a day and kept in the refrigerator which averages between 15° and 16° Centigrade. In some experiments the material was placed in a shaking machine and agitated continuously for 48 hours at room temperature which averages 26° Centigrade in the morning and 28° Centigrade in the afternoon, some days rising to 30° Centigrade. After the 48 hours of agitation at room temperature the material was placed in the refrigerator for 24 hours and then filtered through gauze to separate out the coarse material and the filtrate replaced in the refrigerator until used.

"When the intestines were to be extracted they were first thoroughly washed free from fecal matter, then placed in a 0·5 per cent. phenol solution for from five to ten minutes after which they were placed in a large container of boiled water which was cooled down to at least 37° Centigrade. The tissue was allowed to soak in this water for a few minutes to dilute the phenol which remained intact. By this method a greater percentage of the bacteria on the surface of the intestinal mucosa were destroyed. Following this treatment the tissue was weighed, passed through the meat grinder, and treated in a similar manner to the other tissues."

The animals used in the experiments were all highly susceptible cattle and carabaos, and had been obtained from localities known to be free from rinderpest for a considerable number of years. These animals were brought into the laboratory and kept under observation for certain lengths of time, their temperatures during this period being taken twice a day and their general appearance noted. While under experimentation and until the first symptom of disease appeared the animals were kept in an isolation shed. Usually one or more susceptible animals were placed among them to control the presence of any accidental infection. As soon as the first symptoms of disease made their appearance the affected animal was immediately transferred to the shed where the sick animals were kept.

The following table is drawn up to give a very brief summary of the experiments.

TABLE.

Experiment Number.	Material used for inoculation.	Result.
1	Water extract of liver, spleen and lymph glands, 3 days old, 100 c.c.	Death, 8 days.
2	do. do.	do. 7 do.
3	Phenol (0·5%) extract of liver and lymph glands, 5 days old, 200 c.c.	do. 8 do.
4	Phenol (0·5%) extract of liver, spleen and lymph glands, 5 days old, 200 c.c.	do. 8 do.
5	Phenol (0·5%) extract of heart, 5 days old, 200 c.c.	Bled to death for virulent blood 9 days afterwards showing marked symptoms.
6	Phenol (0·5%) extract of skeletal muscle, 5 days old, 200 c.c.	Showed no symptoms but later proved to be highly susceptible.
7	Phenol (0·5%) extract of liver, spleen and lymph glands, 15 days old, 200 c.c.	Death, 9 days.
8	Phenol (0·5%) extract of caecum and colon, 5 days old, 100 c.c.	Bled to death for virulent blood 9 days afterwards showing marked symptoms and lesions.
9	Phenol (0·5%) extract of larynx, pharynx and base of tongue, 5 days old, 100 c.c.	Showed no symptoms but later proved to be highly susceptible.
10	Phenol (0·5%) extract of liver, spleen and lymph glands, 8 days old, 50 c.c.	Death, 10 days.
11	Phenol (0·5%) extract of liver, spleen and lymph glands, 15 days old, 200 c.c., 3 animals inoculated.	One was bled to death for virulent blood 6 days afterwards showing marked symptoms; the other two, death 9 days after inoculation.
12	Phenol (0·5%) extract of liver, spleen, parotid and lymph glands, 16 days old, 200 c.c.	Death, 9 days.
13	Phenol (0·5%) extract of liver, spleen, parotid and lymph glands, 20 days old, 200 cc..	Death, 11 days.
14	Phenol (0·5%) extract of liver, spleen and lymph glands, 15 days old, 200 c.c.	Developed marked symptoms but on the 10th day commenced to recover and later proved to have become immune.

TABLE—*cont.*

Experiment Number.	Material used for inoculation.	Result.
15	Phenol (0·5%) extract of liver, spleen and lymph glands, 29 days old, 200 c.c.	Developed appreciable symptoms but 13 days later recovery was complete and the animal was shown to have become immune.
16	Phenol (0·5%) extract of pancreas, 5 days old, 100 c.c.	Showed no symptoms but later proved to be highly susceptible.
17	Phenol (0·5%) extract of liver, spleen, parotid and lymph glands, 55 days old, 120 c.c.	Death, 13 days.
18	Phenol (1%) extract of lymph glands, 6 days old, 100 c.c.	do. 10 do.
19	Phenol (1%) extract of liver, spleen, caecum and lymph glands, 17 days old, 100 c.c.; 1–1,000% chlorazene solution was also added 1 day before used.	do. 10 do.
20	Phenol (1%) extract of lymph glands 20 days old, 100c.c.	do. 8 do.
21	Phenol (1%) extract of liver 21 days old, 100 c.c.	do. 12 do.
22	Phenol (1%) extract of spleen 21 days old, 100 c.c.	do. 9 do.
23	Phenol (1%) extract of lymph glands 17 days old, 100 c.c.	do. 6 do.
24	Phenol (2%) extract of spleen 5 days old, 50 c.c. (agitated 48 hours).	Developed a mild attack, treated with anti-rinderpest serum, and later proved to be immune.
25	Phenol (2%) glycerine (25%) extract of spleen 5 days old, 50 c.c. (agitated 48 hours).	Showed no symptoms but later proved to be susceptible. Several similar experiments were tried using liver and lymph glands and it was found that the virus was destroyed in each case where glycerine was added.
26	Phenol (2%) extract of lymph glands 8 days old, 50 c.c. (agitated 48 hours).	Showed no symptoms but later proved to be susceptible. Negative results were similarly obtained by treating liver tissue in the same way and for the same length of time. Heart and intestine extracts were found to lose their virulence in 6 days when treated in this manner.

From the results obtained in the course of these experiments Boynton recommends the use of a 0·75 per cent. phenol extract of organs not over 15 days old in connection with inoculations against rinderpest by the simultaneous method in the field.

"From the results obtained in working with rinderpest it is very plausible that similar or even better results may be obtained with the virus of hog cholera along these lines.

"The tissues best adapted for this work are the liver, spleen, lymph glands, heart, fourth stomach, caecum, and colon."

BOYNTON (William Hutchins). **Note on the Use of Organ Extracts in Place of Virulent Blood in Immunization and Hyperimmunization against Rinderpest.** — *Philippine Agric. Rev.* 1917. Fourth Quarter. Vol. 10. No. 4. pp. 448–455.

"One of the problems in the production of antirinderpest serum is the reduction in the cost of producing virulent material to be used in hyperimmunization. Various methods have been used with more or less success. Nicolle and Adil-Bey (1901) were the first to develop a method by which the virulent material could be increased. When an infected animal presented symptoms of diarrhoea they introduced into the peritoneal cavity a mixture composed of 3 volumes of normal saline solution and 1 volume of a slightly alkaline solution of Martin peptone. They introduced 6 liters of this material into yearling cattle (the quantity varying according to the size of the animal) and after three hours the animal was bled to death, the peritoneal cavity opened and the fluid aspirated. After allowing this fluid to coagulate, the clear liquid was drained off and used. The fluid thus obtained gave an increase in virulent material which was used with success in hyperimmunisation.

"Reudiger (1908) obtained equal results using normal saline solution which he allowed to remain in the peritoneal cavity one to two hours before bleeding the animal to death and withdrawing it. The same author also used a 5 per cent. sodium-citrate solution with equal results.

"Holmes diluted the virulent blood with an equal volume of potassium-citrate solution and claims the diluted blood gave better results than undiluted defibrinated blood.

"Martoglio (1915) has developed the latest method in which he claims to increase the virulent material about 70 per cent. His technique is as follows:

"When the infected bovine presents the buccal lesions, usually at the end of the fourth or fifth day of the fever, less commonly at the end of the third, sixth, or seventh, it is immobilised in the stocks and intubed in the jugular and the carotid on the same side. The jugular is put in communication with a capacious glass receptacle placed on a level with the head of the animal and containing saline solution, sterilised and at a temperature of 38° to 39° C., leaving the outlet tube of rubber closed by compression of pincers. . . . The carotid is put in communication with the receptacle which receives the pest blood, and the bleeding begins.

"When the convulsions preceding the death-struggle begin, the bleeding should stop. The assistant shuts the tube for drawing the blood with a clamp and opens the tube admitting the sodium-chloride solution; immediately the serious symptom-complex changes, the muscular contractions begin to cease, the respiration and pulse that were accelerated become regular and the animal when it has received about as much solution as it has lost blood, enters a period of calm.

* * * * *

"We usually inject enough solution to make two and a half times the volume of blood taken, and without ill results. . . . The operation over the animal returns to its shed without assistance. After a lapse of about 5 or 6 hours the animal is bled from the same carotid, this time until it dies.

"By this method Martoglio claims to wash out the blood vessels and lymphatic system and obtain a potent virus.

"Dr. Stanton Youngberg, Chief Veterinarian, Bureau of Agriculture, and Dr. D. W. Shaffer, formerly in charge of the Phil. C. Whitaker anti-rinderpest serum laboratory, Manila, have been using a simple method of slightly increasing the production of virulent blood, as follows: The injected animal is bled from 2 to 4 liters of blood, depending upon its size, on the second day of temperature; the animal is then allowed to stand over night, during which time the body has an opportunity to replace the volume of the blood lost; on the following day it is bled to death. In the final bleeding practically as much blood in bulk is obtained as would be procured in a single bleeding, which gives an increase in virulent material corresponding to the amount obtained at the initial bleeding."

In the manufacture of the tissue extract the organs recommended for use [see preceding extract] are passed through a meat grinder with twice their bulk of 0·75 per cent. phenol solution, and the same technique as recommended in that paper is then followed. From one bull it was thus possible to obtain 11 litres of filtered extract in addition to 9 litres of virulent blood.

The author then discusses the results obtained by this method, and draws the following conclusions:—

"1. Considering the results thus far obtained it is quite evident that tissue extracts from animals suffering with rinderpest are just as potent as virulent blood when used in simultaneous immunization work.

"2. Any of the methods advocated for increasing the production of virulent material can be utilised, after which the organs can be extracted, thereby obtaining a much greater increase in quantity.

"3. By using Martoglio's method and extracting the organs the output of virulent material is practically tripled.

"4. If the extracts are kept at a temperature of approximately 15° Centigrade they can be used with safety in 2,000 cubic centimetre doses for hyperimmunization.

"5. Considering our results up to date the extracts should not be given in massive injections if they have been exposed for a period of eighteen hours to the climatic conditions found in the Tropics.

"6. These extracts can be produced so easily that this method can be used in any immunization station.

"7. Considering the similarity of hog cholera to rinderpest this method should be as applicable in that disease as it is in rinderpest, thereby reducing the enormous cost of the virus."

YOUNGBERG (Stanton). **Observations on the Immunity to Rinderpest of the Nellore (Indian) Cattle and of the various Nellore-Native Grades.**—*Philippine Agric. Rev.* 1917. Fourth Quarter. Vol. 10. No. 4. pp. 436–447. With 6 charts.

During the year 1909 the Bureau of Agriculture of the Philippine Islands purchased a number of cattle from the district of Nellore, Madras Presidency, for the purpose of ascertaining whether these animals could readily adapt themselves to the climate, feeding, and needs of the country, and also to determine whether they could be used to improve the native breeds of cattle. It was found that the Nellore cattle readily adapted themselves to the conditions in the lower altitudes of the Philippine Islands and that when crossed with native and Chinese dams a very good type of animal was produced. A considerable number of Nellore cattle has thus been imported into the Islands since that date.

The high resistance to rinderpest of the "plains" cattle of India has long been recognised; the idea became prevalent among breeders in the Philippine Islands that this resistance could be transmitted to the offspring produced by crossing with native and Chinese dams. The author, however, produces a considerable amount of evidence gathered from statistics relating to naturally occurring outbreaks and experimental cases which controverts this idea and thus he draws up the following conclusions:—

"1. The pure Nellore cattle are very highly resistant to the Philippine strains of rinderpest, the mortality being insignificant. They are not, however, absolutely immune.

"2. In the case of native cattle, the infectivity of the virus is not appreciably attenuated by being passed through Nellore cattle. This fact makes the latter very dangerous as conveyers of the disease, as they may react without showing clinical evidence.

"3. The half-bred Nellore-native cattle do not inherit the high degree of resistance to rinderpest possessed by the Nellore stock. In infections of moderate virulence they apparently have somewhat more resistance than the native animals, but in virulent infections this resistance does not afford them any protection.

"4. From the inconclusive evidence at hand, the three-fourths Nellore-native grades appear to have a greater resistance than the native stock.

"5. The rinderpest problem of the Philippine Islands can not be solved by the importation of Nellore or other Indian cattle unless possibly by carrying it out to the extent of practically eliminating the native stock."

NOGUCHI (Hideyo). **Further Studies on the Properties of Pure Vaccine Virus cultivated** *in vivo*.—*Jl. Experim. Med.* 1918. Mar. 1. Vol. 27. No. 3. pp. 425–442.

In a paper published in 1915 Noguchi showed

"that a sample of vaccinia virus free from bacterial impurity and at the same time of sufficient strength for practical purposes, can be propagated in the testes of certain animals, particularly rabbits. There were still several points, however, which seemed to require further investigation. It was not known whether or not, through continuous cultivation *in vivo* in the testicular tissues of rabbits, the biological properties of the virus would finally undergo modifications. Since the natural habitat of the virus is the skin, it is not improbable that the new medium in which it has been induced to grow might have a deleterious influence upon it. It was necessary to determine the viability of such a virus under varying conditions, that is at different temperatures, with the addition of antiseptics, etc. It was desirable also to compare the resistance and viability of the testicular strain with those of the virus propagated in the dermal tissue. These are questions not merely of purely academic interest, but of practical importance, inasmuch as the proper utilization of the new vaccine depends to a great extent upon the right understanding of its properties."

The nature and results of the author's experiments are indicated in the following summary:—

"1. The virulence of vaccine virus for the testicular tissues increases until its maximum is finally reached. The selective increase is not associated with any loss, reduction, or modification in its virulence for the skin. A highly potent testicular vaccine is also highly active for the skin.

"2. The testicular strain of vaccine virus has no more tendency to localize in various organs than the ordinary skin strain. Both may localize in adjacent lymph nodes when introduced intravenously, subcutaneously, or intratesticularly in sufficiently large quantities, but other organs are not involved.

"3. Intravenous inoculation of an excessive amount of a powerful vaccine virus (1 to 2 c.c. of undiluted stock emulsion), irrespective of whether it is from the testis or the skin, will result in a generalized eruption over the entire body surface of rabbits. The eruption may be confluent on mucous membranes of the mouth, nostrils, genitalia, etc. Intratesticular or subcutaneous inoculations of the same virus fail to produce this effect.

"4. Subcutaneous or intravenous introduction of much smaller quantities of the virus does not cause an appreciable local or general reaction in the rabbit. But the animals which have once received these injections become refractory to a subsequent vaccination as applied to the skin. It seems probable that an active immunity has been conferred.

"5. Experiments on the viability and resistance of the testicular strain of vaccine virus indicate that the virus is best preserved when emulsified with Ringer's solution or 0·9 per cent. saline solution. Distilled water, while apparently one of the best diluents, fails to keep the virus active as long as Ringer's or saline solutions. As would be expected, the lower the temperature is, the longer the virus retains its viability. At 18° or 37° C., the deterioration of the virus proceeds rapidly. However, a small part of the virus survives after many weeks' standing at 37° C.

"6. Of the two most commonly employed chemical agents for the ripening (eliminating bacteria) process of the green vaccine pulp, glycerol and phenol, the latter is the less injurious. Phenol in concentration above 2 per cent. destroys the virus within 24 hours at any temperature, but it has almost no injurious effect when used in 0·5 to 1 per cent. On the other hand, glycerol is a powerful vaccinicide. When used in full strength it destroys the virus within 24 hours, even at 4° C. In a concentration of 40 per cent., that ordinarily recommended for the ripening, the virus retains some of its virulence for about half a year at 4° C., while at higher temperatures the same concentration kills the virus within 1 to 2 months. The virus preserved in distilled water or Ringer's solution under similar temperature conditions remains more active during this period. From this it may be concluded that glycerol is not an indifferent agent, as is assumed by many, but a powerful vaccinicide when used in high concentrations. The injurious effect is markedly accelerated at 18° or 37° C.

"7. The vaccine virus retains its virulence better in a sealed tube containing either hydrogen, nitrogen, or air than in an open receptacle. The virus deteriorates when placed in a sealed tube with oxygen or carbon dioxide.

"8. Desiccation decreases to a considerable degree the virulence of the vaccine virus. In the dried state the virus retains its viability about as long as does the emulsion, but it is not protected from the deterioration caused by age under various conditions.

"9. Iodine is a powerful disinfectant for the vaccine virus, but its sodium and potassium salts have no effect. Various bile salts destroy the vaccine virus when employed in sufficient concentration."

MISCELLANEOUS.

VELU (H.). **La Septicémie contagieuse du porc au Maroc.** [Contagious Septicaemia of the Pig in Morocco.]—*Bull. Soc. Path. Exot.* 1918. Feb. Vol. 11. No. 2. pp. 117–124.

Throughout the year 1917 very serious and markedly contagious outbreaks occurred in several herds of pigs in the Chaouia region of Morocco. The first outbreaks of enteritis, which took place in the spring, occurred among sucking pigs and were considered to have been set up by cold. Later, during the summer, the principal lesions

affecting the young pigs were oedematous swellings around the neck and head, and these lesions were attributed to anthrax on account of the existence of that disease among bovines. Still later, in the autumn, older pigs from 5 to 10 months old became affected with pleuro-pneumonia.

Briefly, the author sums up from clinical observation that there exists a markedly contagious disease of pigs in Morocco affecting preferably young or middle-aged subjects, characterised mainly by the lesions of a septicaemia, pulmonary hepatisation, swelling and haemorrhagic infiltration of the lymphatic glands, congestion and petechiae of the skin and mucous membranes, congestion and catarrhal inflammation of the intestinal mucous membrane, but with no croupous or diphtheritic lesions.

A bacteriological study almost invariably revealed the presence in the bronchial glands, pulmonary lesions and exudates of an ovoid bacterium considered to be a Pasteurella. An experimental study showed that this ovoid bacterium was pathogenic for the pig, and that a disease similar in appearance to the natural disease could be reproduced by inoculation of cultures. The pigs became contaminated through the medium of infected faeces and the channels of infection were the upper respiratory and digestive tracts. No filtration experiments were performed and these were considered unnecessary by the author inasmuch as he succeeded in reproducing the disease in a susceptible pig by inoculating a culture of the organism after it had been transmitted in series through two rabbits and artificial culture media.

[The probability that the natural disease was caused by a filterable virus is by no means excluded by such experiments as the author describes.—Ed.]

Woods (H. S.). **Mysterious Outbreak of Disease among Cattle.**—*Rhodesia Agric. Jl.* 1918. Feb. Vol. 15. No. 1. pp. 29–31.

In this article the author records an outbreak among cattle in North Western Rhodesia in the autumn of 1917, probably set up by poisoning. The mortality varied from 2 to 22 per cent. on different farms. The affected animals showed acute nervous symptoms which varied in intensity; in the more acute cases the animals were either dead in a few minutes or had numerous fits, in any one of which death might occur; the less acute cases might last up to 24 hours, when the animals usually recovered. Microscopic examination of smears from the blood and other organs gave negative results.

Togoland. **Report upon a Disease among Goats in the Lome and Lomeland Districts of Togoland.**—MS. Reports received from Colonial Office, dated 27th Dec. 1916 and 30th Nov. 1917. [By Oakley (Philip D.) & Popham (H. B.).] With 2 photographs. 13 pp. f'cap.

This correspondence contains information supplied by the Political Officer of the above districts (Popham H. B.) and the Medical Officer, Lome (Oakley P. D.) regarding an outbreak of disease among goats n the country around Tsewie. The disease was first reported in this locality in November 1916. The morbid changes produced are said

to resemble very closely those observed in nodular leprosy, hence the native name Myi meaning leprosy. Animals of all ages and both sexes are affected to a similar degree. The disease is not known to affect sheep or cattle. It is almost invariably fatal within from 4 to 5 months after its onset.

The affection is first manifested by the appearance of small sores all over the body. These sores grow rapidly in size and tend to discharge a white sticky matter which dries up forming hard irregular masses. The hair begins to fall off particularly on the hind quarters. After a short period the animal begins to move about slowly and shows inappetence; the buccal mucous membrane becomes ulcerated marked salivation being thereby produced; a white frothy substance is also discharged from the nose and a thick white fluid from the eyes. Swellings are produced around the eyes and nostrils. The legs become covered with hard white crusts, and the animals are also stated by natives to become affected with marked diarrhoea. Forty affected animals were examined by OAKLEY himself but no diarrhoea was observed in the cases which came under his observation. Post-mortem examination of one goat found dead of the disease showed no lesions in the internal organs. Microscopic examination of blood films gave negative results. Smears were also taken from the nodules and stained, without furnishing any indication as to the cause of the disease. No scrapings appear to have been examined as to the presence of mange parasites. Measures were taken to prevent the further spread of the disease by destruction and burning of affected goats and segregation of in-contacts.

From the description of the disease, the Acting Pathologist, Accra, (INGRAM A.) suggests that it might be a blastomycosis. The real nature of the disease, however, can only be determined by submitting an infected animal or the diseased parts to a pathologist for examination.

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RECENT LITERATURE.

[Continued from this *Bulletin*, Vol. 6, No. 1, pp. 61–65.]

PROTOZOAN PARASITES.

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